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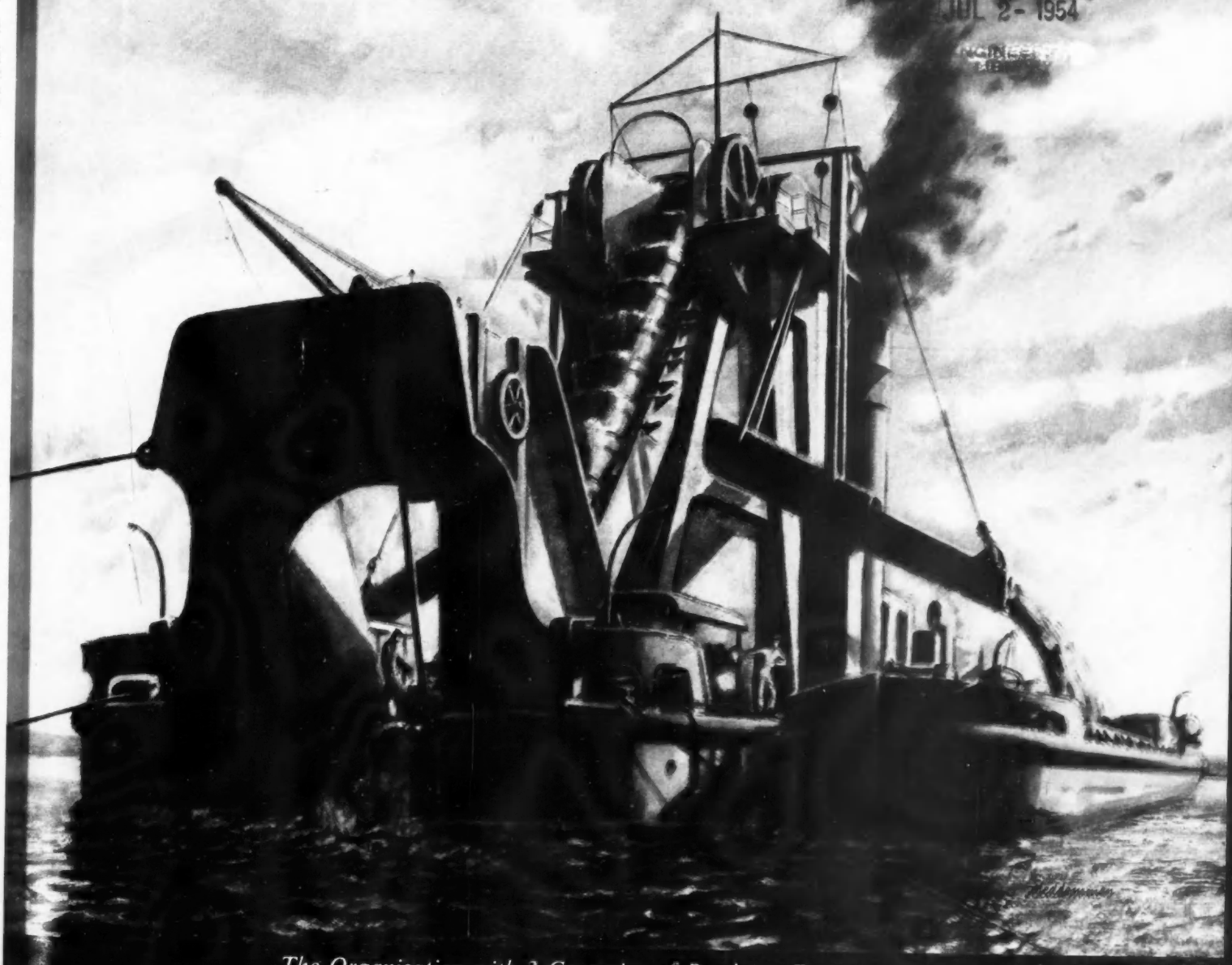

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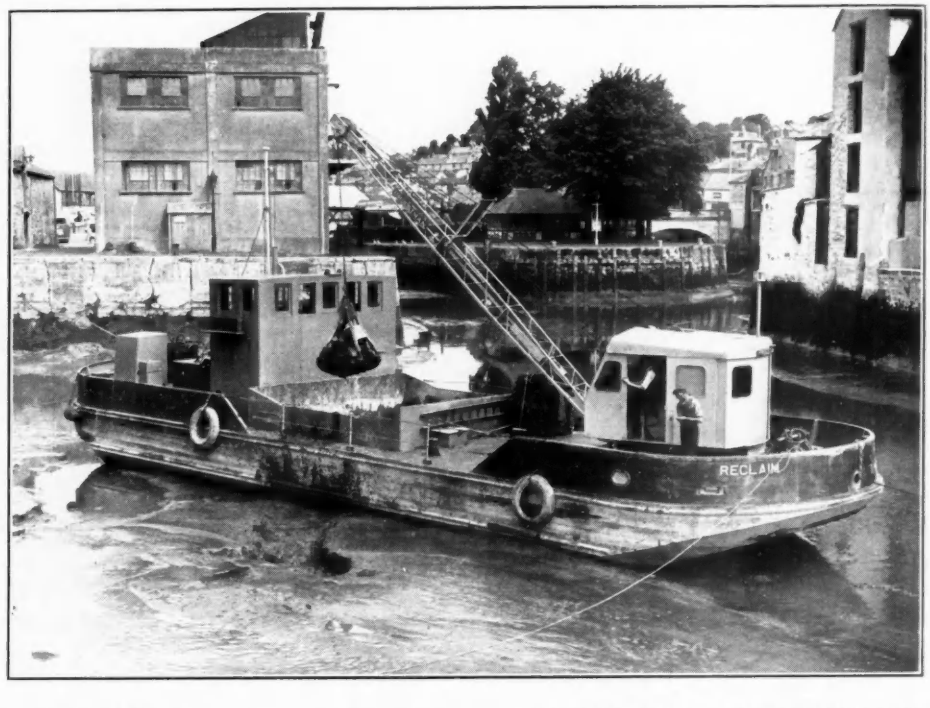

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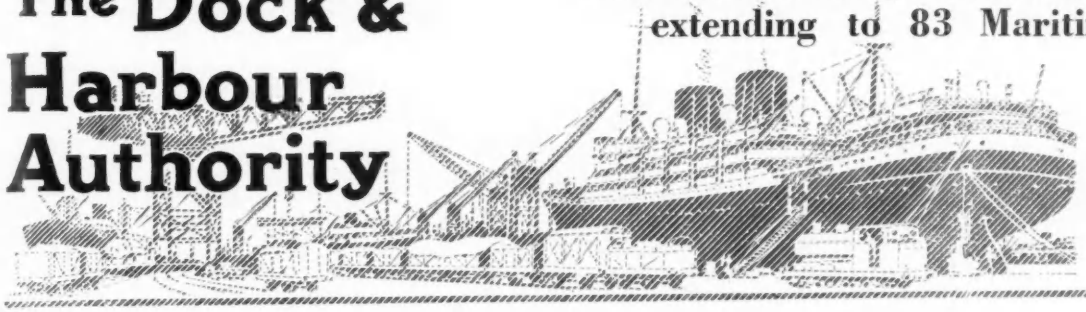

No. 404

Vol. XXXV.

JUNE, 1954

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Editorial Comments

Oil Port at the Isle of Grain.

Oil and its derivatives now form the largest single item of the import and export trade of the world. Since the war, a great change has taken place in British oil policy, chiefly due to the unsettled international situation. For this reason, it is now considered politic and more economic to effect the refining of crude oil near the oil markets rather than the sources of supply.

In addition there has been a phenomenal increase in oil consumption during the post war years, so that the rapid and safe handling of oil at ports has become a matter of the greatest importance at all the importing and exporting centres. In order to keep pace with this growing industry, a corresponding increase in oil handling facilities has also been found necessary.

Our leading article this month deals with the design and construction of a new oil jetty at the Isle-of-Grain for the Anglo-Iranian Oil Company. This will be the seventh jetty at this new oil refinery in the River Medway.

In previous issues of this Journal, examples have been given of several forms of oil ports and of various types of jetties which have been built to accommodate large modern oil tankers, and it is of interest to compare the various methods of construction adopted to cope with differing site conditions.

A study of these previous articles and observation generally, also reveal an extraordinary diversity in the design of jetty structures which are intended to fulfil almost identical requirements. In the Thames estuary, for example, on similar ground and within a few miles of each other, there are several different types of jetty for berthing oil tankers of the largest size. The problem of deciding upon the type of berth to be adopted for any particular set of circumstances is one of great importance and complexity, and one upon which much thought must be expended.

In the jetty described in the article which follows, the principle adopted is the formation, within the structure, of strong points to take the principal berthing blows, while the type of fender unit is one that incorporates rubber blocks of large dimensions, the use of which is now receiving increasing attention. It is also interesting to note that cathodic protection has been applied to prevent corrosion of the steel box piles used in the structure.

Hydraulics Research.

Extracts from the Report of the Hydraulics Research Board and that of the Director of Hydraulics Research for 1953 appear on another page. While the research studies carried out during the past year are impressive, it may be expected that considerably augmented work will result when the building and equipping of the new Station at Wallingford is completed.

There are several problems of importance at present under investigation by the Board. Probably the most significant is a study of the East Coast Storm-surge and Floods of 1953, and problems concerned with flood protection in London and the Thames Estuary which have arisen as a result of that occurrence. This work was undertaken at the request of the Waverley Committee which, readers will remember, was constituted to consider the whole question of sea defences in Great Britain.

The feasibility of a Severn Barrage has for many years engaged attention in the United Kingdom, and it is of interest to learn that a pilot model of the river is now in operation, to determine certain data for the construction of a large tidal model of the Severn River.

Other studies which are being undertaken are of considerable interest. These are, *inter alia*, investigations into the possibility of large scale land reclamation in the Wash (referred to in these columns last month) and siltation in the Port of London Authority's tidal basin and docks at Tilbury. In addition to studies relating to conditions in Great Britain, work has also been carried out for other Commonwealth countries.

Progress has been made with the siltation problem at Tilbury and recommendations have been put forward. Those unacquainted with the P.L.A. no doubt will wonder why the inconvenience and expense of dredging 300,000 cu. yds. per annum from the docks, and an even larger amount from the basin, has not stimulated, much earlier, some investigation into the effect of the impounding pumps and the run-in of Spring Tides.

In general, the investigations described in the Reports are of more than purely local interest, and a study of them by engineers concerned with such problems will be fruitful.

In some sections of the British Press during the past few years, there has been a tendency to decry the work and expenses of some of the Government research departments. Original research has been work in which this country has been peculiarly successful and we are not in agreement with any policy aimed at curtailment of facilities for research work sponsored by the Government, in whatever field it is directed. The work of the Hydraulics Research Station of the Department of Scientific and Industrial Research seems likely to grow in importance, and we shall look forward to hearing details from time to time of further studies being undertaken.

Protection from Floods.

Coincident with the foregoing, the final report of the Departmental Committee on Coastal Flooding, of which Lord Waverley is chairman, has also been published. The Committee was appointed in April, 1953, and three months later published an interim report recommending the system of flood warnings, which was put into operation in September.

The final report endorses the present arrangements for the distribution of responsibilities for sea defences between river boards and coast protection authorities, and between the Minister of Agriculture and Fisheries and the Minister of Housing and Local Government.

The committee recommends that the maximum standard of protection to be afforded by public authorities against flooding should be that sufficient to withstand the floods of January, 1953. This should be provided where flooding would affect a large area of valuable agricultural land, or would lead to serious damage to property of high value. Elsewhere, the defences should be at a standard which would have been thought adequate before the floods of January, 1953.

Editorial Comments—continued

The Committee also endorses the present basis of Government assistance, whereby some part of the cost of sea defence improvements fell locally.

These recommendations are to some extent tentative, for the committee lays stress upon the need for further scientific examination of the whole problem of coastal flooding. In recommending the constitution of two advisory committees to ensure the co-ordination of research work, the Report urges that " there should be close co-operation on both sides of the North Sea between scientists, engineers and Governments." This indeed is most desirable, for Holland can be much more seriously affected than the United Kingdom by storms from the North Sea, and the U.K., by virtue of its geographical position, can be of great assistance, both as regards research and warnings of the imminence of storm surges.

One of the most interesting proposals is that connected with the Thames Estuary and the protection of London, large areas of which are particularly vulnerable to flooding. This suggests an examination into the possibility of erecting a barrage structure across the Thames at Purfleet which could be closed on the advent of a surge.

It is recognised that this scheme involves " formidable engineering and financial considerations," but the committee in setting out the technical problem was of opinion that an investigation should be made. Experiments had already been carried out on the Port of London Authority tidal model of the Thames. In these, tests showed that if, four hours before the arrival of the peak of the tide-cum-surge, barrage gates were lowered gradually into the river until an opening of only 10 per cent. of the sectional area of the river remained, the maximum water levels at London Bridge would be reduced by about 5-ft., without any increase in the water levels downstream. The waterway would be clear except on the rare occasions of impending high flood.

This proposal, originating with the London County Council, was referred to in these columns in our issue of December last, and readers will remember that in our February number reference was made to a somewhat similar proposal by the Netherlands State Waterways to construct two " sliding doors " across the Hollandse Ijsel River as a flood prevention measure near Rotterdam.

Among other suggestions, the report recommends that full use should be made of the Town and Country Planning Act to prevent sporadic and ill-considered development near the coast. Legislation is urgently necessary to confer powers to protect land against flooding from the Thames upon the riparian local authorities, to establish a joint committee to co-ordinate the flood defences, and to bring the basis for distributing the cost of the defences broadly into line with that operating elsewhere.

On coast erosion, it is interesting to note that the committee believes that since Tudor times more land has been won from the sea in Britain than has been lost to it.

The Waverley Committee has carried out its work in a surprisingly short time, and the Home Secretary has given a friendly reception to its report. He has accepted its recommendations on the standards of safety in coastal defences, and it is to be hoped that equal care and despatch will be given by the Government in its promised early consideration of the other points to be resolved.

The Report of the Departmental Committee on Coastal Flooding (Cmd. 9165) is published by the Stationery Office (2s. 6d.).

Tonnage Measurement of Ships.

Readers will remember that the question of tonnage measurements of ships has been dealt with at length in recent issues of this journal, both from the shipowner's and port authorities' points of view.

The matter has been debated in Parliament and the Bill having now become law, the Minister of Transport and Civil Aviation, has made an Order appointing the 1st July, 1954, as the day when the Merchant Shipping Act, 1954, will come into operation.

The Act amends Section 78 of the Merchant Shipping Act, 1894, so as to provide that, in calculating the net tonnage of a ship, where the propelling power space measures exactly 13 per cent. of the gross tonnage of the ship the deductible allowance is 32 per cent. of such gross tonnage, and where it is less than 13 per cent. the deduction shall be proportionately reduced from 32 per cent., i.e. a propelling power space of 12 per cent. will get an allowance of 12/13 x 13 per cent. of the gross tonnage, and so on.

An important provision in the Act is that the deduction for the propelling power space may only be allowed if the space provided for the working of the boilers and machinery and the ventilation and lighting of the space are adequate.

The new Rule will apply to any ship the keel of which is laid on or after 1st July, 1954, and, if the owners so request in writing, to any other ship. Applications for re-assessment of the propelling power allowance of an existing ship should be made on form Surveys 6 to the appropriate Marine Survey Office.

During the debate in Parliament certain fears were expressed as to the possibility that the new methods for calculating nett tonnage might adversely effect the safety of vessels. These doubts appear to have been set at rest, for the law concerning load lines will in no way be affected by anything contained in the new Act, and a smaller engine room space should enable modifications in ship design which will favour greater safety.

In cases where this space is under 13 per cent. the result will be a slight increase of registered tonnage and therefore of liability for dues. This will benefit dock and harbour authorities and from the shipowners' point of view will be more than offset by increased carrying capacity and possibly reduced construction costs.

In general therefore, the conclusion reached is that the new method of assessment will not necessarily be at the disadvantage of port authorities, while benefit in other directions will accrue to shipowners.

Copies of the Order, entitled " The Merchant Shipping Act, 1954 (Commencement) Order, 1954 " (S.I. 1954 No. 679 (c.6)), price 2d. (by post 3½d.), and of the Merchant Shipping Act, 1954, price 3d. (by post 4½d.), may be obtained from H.M. Stationery Office.

Palletisation and Shipping—1954.

It is doubtful whether any subject has created greater interest in the port industry during post war years than palletisation. One of the reasons for this is that, although there have been substantial developments in short sea trading, practically no palletised traffic has yet appeared in the transocean trades. When and how such traffic will develop is a much-discussed, controversial question.

On page 58 of this issue, is printed the first of two articles with the above-mentioned title. This article outlines developments to date in both the short sea trades in which all kinds of pallets—flat, box, sides, nesting—are being employed in increasing quantities, and in transocean trading, where pallets are being employed (when they are employed at all!) as shipping companies' tools.

It is obvious that to bring about the palletisation of goods carried in deep-sea vessels there must be greater or new inducements to some, at least, of the interests involved, in the " throughout movement " chain. Pallet standardisation is said to be necessary before these inducements can become tangible and it is therefore of interest to note that the second meeting of the technical committee set up by the International Organisation for Standardisation to deal with this question is being held in London (from 21st to 23rd June). The second article, which will appear in the July issue, will deal with pallet standardisation and will also discuss some of the recommendations made at the I.S.O. meeting.

Increased Trade at South Wales Ports.

Returns issued by the British Transport Commission show that trade handled at the South Wales ports in the first five months of this year amounted to 8,560,449 tons, compared with 8,303,464 tons in the corresponding period of 1953. The improvement was entirely due to increased imports, exports showing a slight decrease. Imports rose from 3,741,814 tons to 4,036,005 tons, but exports declined from 4,561,650 tons to 4,524,444 tons.

All ports except Swansea, Barry and Penarth handled a larger total trade than last year, although only Port Talbot registered improvement on both inward and outward sides. At Cardiff, Swansea, Barry and Briton Ferry imports were up and at Newport exports were heavier. At Penarth both imports and exports, which were all coastwise, were lower.

New Oilport at the Isle-of-Grain

Refinery and Jetties Constructed on River Medway

(Specially Contributed)

IN June, 1950, construction started on a £40,000,000 project for a new Oil Refinery at the Isle of Grain, Kent, for the Anglo-Iranian Oil Company to process 4 million tons of crude oil per annum, and to produce approximately 3.75 million tons of products. A refinery of this magnitude necessitates a correspondingly large oil port with ample jetty facilities for the handling of liquid cargoes and the speedy turn-round of tankers, of which the sizes may be anything up to the "monster" class of 32,000 tons deadweight. Experience has proved that on an average each jetty can be estimated to handle up to 2.5 million tons per annum, dependent on the proportions of crude oil and products involved. Although the sanctioned crude import capacity of the refinery is 4 million tons, it may be necessary at times to run the plant at the rate of 5 million tons per annum and it was therefore necessary to provide five tanker jetties to cope with the movements of oil. In addition, a special type of jetty was required for the loading into barges and small coastal craft of lubricating oil both in bulk and drum packages. The following is a brief description of this new Medway port.

The Isle of Grain is a promontory of low lying land protected by sea walls situated between the River Thames on the North and the River Medway on the South. The refinery is sited on the River Medway shore where sufficient frontage is available to supply all the required facilities and also leave room for future expansion.

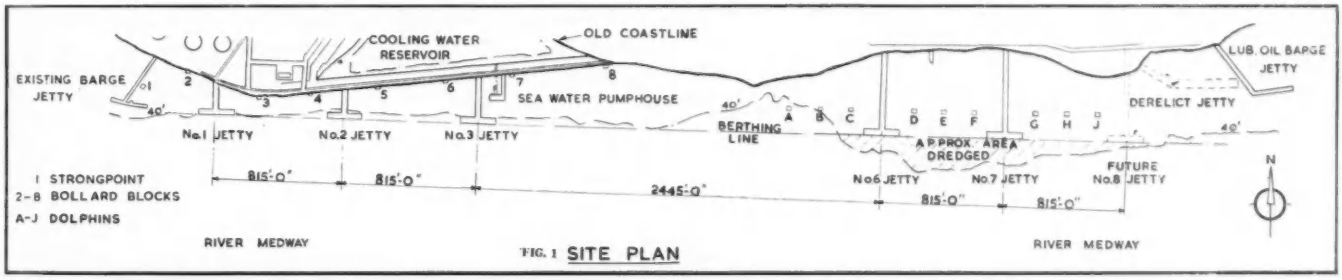


FIG. 1 SITE PLAN

The Entrance Channel.

The River Medway has a deep stable navigable channel which for many years past has provided ready access for H.M. ships to Chatham and Sheerness without the need for dredging. The entrance channel was 1,100-ft. wide with a minimum depth of 22-ft. below Low Water (Chart Datum)—Chart Datum is 8.37-ft. below Ordnance Datum (Newlyn) at Sheerness. It was decided that a channel 800-ft. wide with a minimum depth of 28-ft. below Low Water O.S.T. would be sufficient, giving ready access at most states of the tide to the majority of tankers and reasonable restricted entry to the 32,000 ton tankers having a laden draft of 35-ft. To achieve this depth, dredging had to be carried out over a 3½ mile length of channel. In view of the large area to be surveyed both before and after dredging it was decided at an early date that the hydrographic survey work should be carried out by Echo sounding using the circle chart method of horizontal control. In the Spring of 1952, a contract was drawn up to cover the dredging of this channel which involved the removal of 400,000 cu. yards of spoil and was awarded to the Westminster Dredging Co., Ltd. The work was carried out with bucket dredgers with the cutting edge set to 29-ft. below L.W.O.S.T. to ensure a final depth of 28-ft. The material dredged consisted of silty sand with small shells and was taken out to the Black Deeps in hoppers and deposited.

A check survey was carried out a year later and the general indication was that the soft mud, which might be expected to drop into the channel after the dredging, had been washed away leaving much of the channel slightly deeper than it was immediately after dredging. At the seaward end of the channel there were a few areas which had silted to a depth of 27-ft. below L.W.O.S.T. In addition on the north side of the channel the dredged slope had not maintained itself but crept forward slightly into the channel. However, the changes were not considered serious and no maintenance dredging has so far had to be carried out. A further check survey will be carried out this summer and a careful watch kept on the newly dredged channel for a number of years until the future trends of this channel are known.

Jetty Type.

In the meantime the planning and construction work on the tanker berths had been proceeding. It was decided to adopt the individual "T" head type for the following reasons:—

(1) Due to the river current berths parallel to the shore were essential, and an open piled construction was required to minimise interference with the movement of silt.
(2) Short shore arms would be possible due to the closeness of deep water to the shore line
(3) The Tee Head Jetty would lend itself to the Foreshore and pipe line and pipetrack layout.

Depth of Water.

It was required to dock any size of tanker at this new oil port and therefore sufficient water at all states of the tide must be available for the 32,000 ton tankers of 35-ft. laden draft. It was therefore decided to provide a depth of water of 40-ft. below Chart Datum at the Jetty Heads. This was practicable in the case of Jetties 2 and 3 with a shore arm length of 200-ft. and 270-ft. respectively (Fig. 2), but due to the necessity of siting Jetties 6 and 7 on an incurve of the river bank and where the water was somewhat shallower, it was found more economical to limit the shore arms to 460-ft. and 530-ft. respectively and carry out a small amount of dredging, which was included in the Medway dredging contract.

The tidal range of the River Medway is comparatively large and the relevant data is included in the following table:—

Highest High Water	+	22.61	
Mean High Water Spring	+	17.30	
Mean High Water Neap	+	13.37	All levels related
Mean Low Water Neap	+	2.90	to Chart Datum.
Mean Low Water Spring	+	0.70	
Lowest Low Water	−	5.10	

After careful consideration a Jetty Head deck level of +25.87 Chart Datum was selected bearing in mind that tankers varying from small coastal tankers to 32,000 tons tankers would be using the jetties.

Planning the Port.

The layout of the oil port required careful consideration because the best possible arrangement of the numerous pipe lines to the refinery and the required number of oil berths had to be fitted in a limited foreshore area where two jetties already existed. The

New Oilport at the Isle-of-Grain—continued

final alignment of the berthing line was established after a series of float tests had been made to determine the course of the tidal currents.

As can be seen on the site plan (Fig. 1) the foreshore was originally cut by a large bight which did not lend itself to a satisfactory

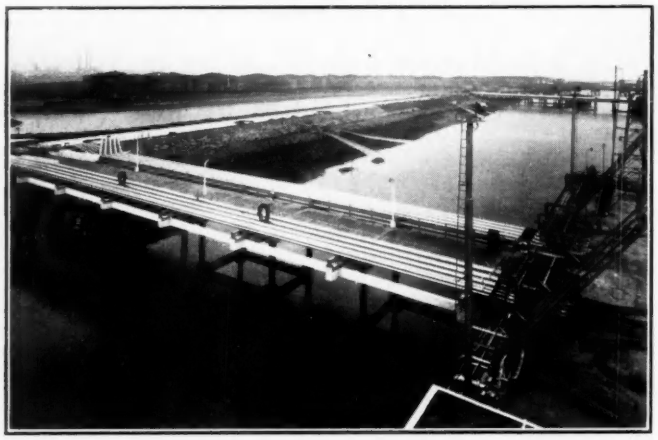


Fig. 2. Showing the Shore Arm and part of the jetty head of No 2 Jetty. In the background can be seen the new section of the sea wall enclosing the Cooling Water Reservoir.

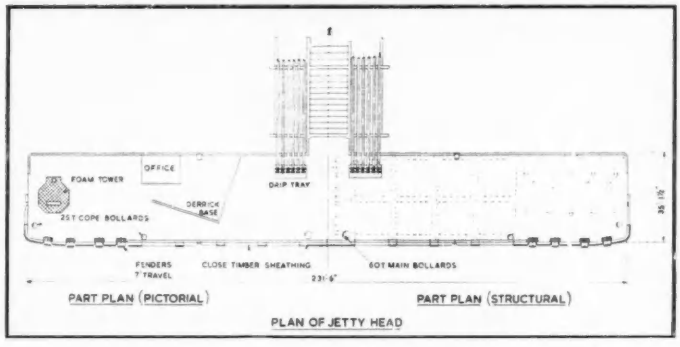


Fig. 3.

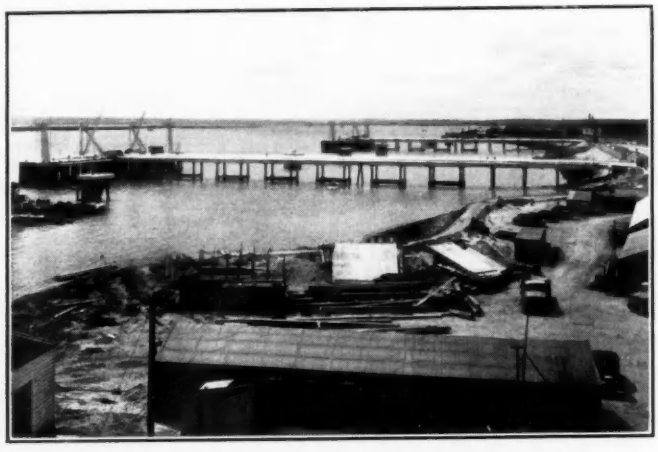


Fig. 4. Showing No. 7 Jetty (foreground) and No. 6 Jetty. The raking piles in the centre of the shore arm together with lower bracing beams can be seen.

layout. It was decided at an early date that the foreshore should be re-aligned in this area by means of a sea wall thrown across the bight, the enclosed area to act as a cooling water reservoir for the refinery units (Fig. 2). From a consideration of the size of tankers it was decided that a jetty spacing of 815-ft. was essential and a jetty layout bearing this in mind was developed. No. 8 Jetty is not required at this stage but can be built at any future date should the need arise. No. 1 Jetty as shown is built in the same position as one which had been used for some 40 years by the Medway Oil and Storage Co., and indeed continued in use until the time of demolition in June, 1953. This jetty was in poor condition having been damaged during the war and it was decided it would be more economical to replace it with a concrete structure, similar to the others but slightly smaller as tankers of up to 16,000 tons only would be berthed at this jetty.

Sea Walls.

Close liaison was maintained during the development of the port with the Kent River Board and the Medway Conservancy and it was agreed that all sea walls newly constructed would be raised above previous levels and A.I.O.C. would be responsible for all work where the foreshore road was an integral part of the sea wall. It is interesting to note in this respect that the crest level of +26.87 Chart Datum (+18.50 O.D.) advocated by the Kent River Board was very well chosen in the light of the February floods of 1953 when the new sea wall was neither overtopped nor breached.

Site Test and Foundations.

Borings in the river bed were made before the jetty structures were designed and in general it was found that there was about 35-ft. of soft silty blue-grey clay overlying a layer of sand and gravel of 4-ft. to 12-ft. thickness with the London clay underneath.

It was decided to found the piles in the sand and gravel stratum, with a varying vertical pile length of some 70-ft. to 100-ft. In the circumstances reinforced concrete piles were not considered to be a practical proposition and it was decided to use steel box piles (Larssen B.P.4). A working load of 80 tons per pile was adopted and piles were normally driven to a specified set in the gravel. In a few cases where piles penetrated the gravel layer without reaching the desired set, they were extended and driven on into the London clay until the penetration was adequate to provide the required resistance.

After driving, the piles were hearted with reinforced concrete by a colloidal process.

The number and layout of piles in jetty heads 2, 3, 6 and 7 is generally identical except for a slight variation in the case of No. 2 Jetty, made necessary by local variations in the sub-soil conditions. There are 113 piles in each head of which 57 are vertical and 56 raked at 1 in $2\frac{1}{2}$, the arrangement of which is shown in Fig. 3. In No. 1 Jetty, designed to receive the small tankers, there are 101 piles of which 51 are vertical and 50 are rakers. Along the shore arm the pile bents, consisting of two vertical piles, are spaced at 27-ft. 6-in. centres. The long shore arms to jetties No. 6 and 7 receive lateral support approximately half-way along their length by one pair of raking piles driven to form an " A " frame (Fig. 4).

The vertical piles were driven from floating craft, using a 4 ton single-acting hammer, while the raking piles were in general driven from the concrete decks of the jetties through holes left for this purpose.

Jetty Head.

The four main jetty heads consist essentially of a concrete deck 231-ft. 6-in. long by 35-ft. 3-in. wide forming a working platform supported on vertical piles and braced laterally and longitudinally by raking piles against impacts and mooring forces from ships. The lateral raking piles are for the most part concentrated at each end and in the centre of the jetty and take the principal berthing blows. The longitudinal rakers are provided in the centre section only. In these three sections where the raking piles occur a solid reinforced concrete deck is provided varying in thickness from 3-ft. 6-in. to 3-ft., the resulting slope taking care of surface drainage (Fig. 5). Elsewhere the deck is framed on beams at approximately 16-ft. centres in both directions (Fig. 3).

It is important to remember when dealing with loaded tankers that unlike cargo ships the free board is very small varying from 6-ft. $8\frac{1}{2}$-in. for a 12,000 deadweight ton to 11-ft. 6-in. for a 32,000 deadweight ton vessel. In view of this the flexible fender units have to be extended lower down the face of the jetty than would otherwise be necessary. A lower deck with its soffit a little above low water at +5.77-ft. Chart Datum has been provided to act as

New Oilport at the Isle-of-Grain—continued

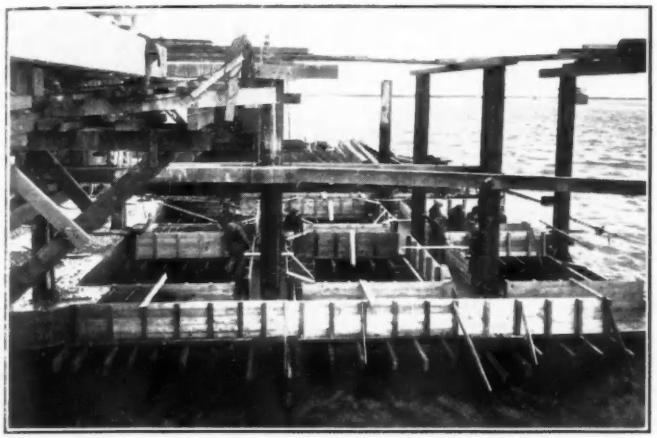


Fig. 6. Showing the erection of shuttering of concrete beams connecting the strongpoints of the lower deck.

bracing and reduce the unsupported length of the piles (Fig. 5). In the three sections where raking piles occur a solid concrete deck of 2-ft. 6-in. thickness forms " strong-points " which are connected by a horizontal girder of " Vierendoel design " (Fig. 6).

Along the front edge of the jetty, walls are provided between the decks in the central and end sections where recesses are provided to accommodate the fender units and their ancillary fittings.

With the exception of a small number of skirt units at each end and in the centre of the jetties below low water, which were precast, all concreting was carried out *in situ* from the floating craft, the total amount of concrete in each Jetty Head being 1,500 cu. yds. Concreting of the lower deck, walls and upper deck was carried out simultaneously and the average time taken to complete each section of the work was as follows:—

Lower deck	...	...	19 weeks
Walls	...	...	13½ ,,
Upper deck	...	...	13½ ,,

The design of No. 1 jetty head is essentially the same except that the dimensions are reduced to 200-ft. long by 35-ft. wide and no fender units are provided. Provision has been made in the design to allow for extension at each end and incorporation of flexible fender units, should this berth ever be required to accommodate 32,000 ton tankers. It is interesting to note that when the old jetty at this site was demolished it was found possible to extract the screw piles which penetrated approximately 20-ft. into the river bed with a direct pull from a floating crane of 50 tons capacity,

Fig. 7. Showing the precast concrete beams of the shore arm in place and ready to be grouted into the muffs on the piles.

except in a few cases where the shaft pin had corroded and broke under the strain. The cast iron screws varied from 3-ft. 6-in. to 4-ft. in diameter and the shafts consisted of 6-in. dia. solid steel, 12-in. tubular steel or 15-in. dia. concrete filled tubular steel.

Shore Arm.

As has already been stated only vertical piles have been used on the shore arm, except in the cases of Nos. 6 and 7 jetties, while to avoid any lateral berthing forces being transmitted to this structure and to allow for expansion from the shore outwards, a 2-in. gap separates it from the Tee Head.

To facilitate and accelerate the construction it was decided to employ a system of precast, prestressed concrete beams grouted into spun concrete muffs slotted over the piles (Fig. 7). Supported

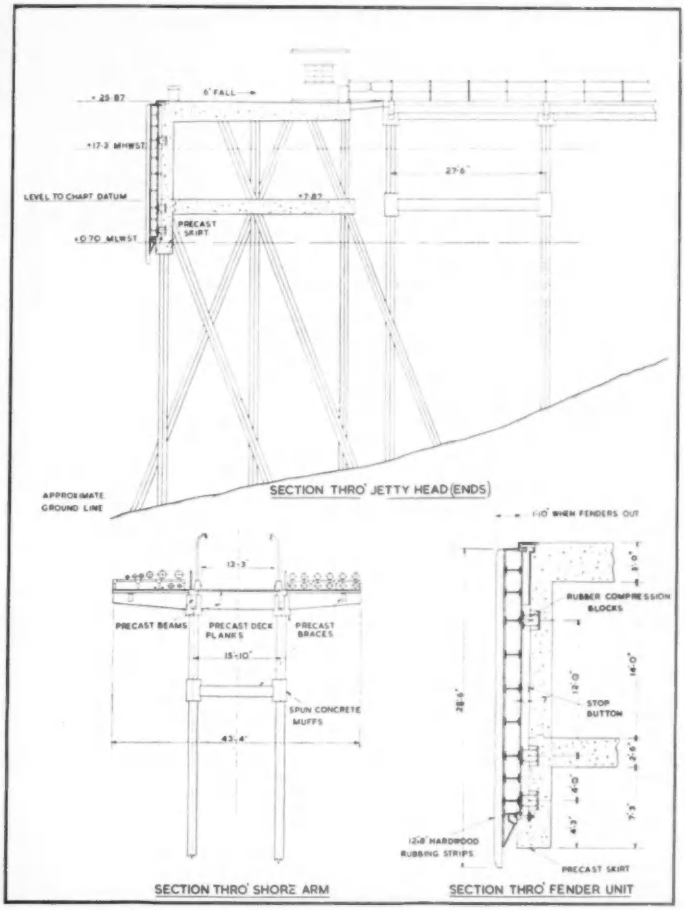


Fig. 5 (above). Fig. 8 (bottom left). Fig. 9 (bottom right).

on this system of beams is the roadway consisting of 4½-in. thick prestressed planks. The cantilever pipe supports were cast *in situ* and carry prefabricated steel racks which were planned in such a way as to provide ample facilities for the addition of future pipes should the need arise (Fig. 8).

Shore Abutment and Pipe Culverts.

The shore abutment and pipe culvert under the Foreshore roadway were combined in one structure of cellular construction. It was anticipated that the settlement of the crest of the new sea wall at Nos. 2 and 3 Jetties would be in the order of 2-ft. but would be considerably less where the level of the sea wall had only been raised at the other jetties. The corresponding settlement of the shore abutments has been accommodated by the provision of a shore span hinged at the last pile bent and the abutment structure.

Fender Units.

Four fender units were placed at each end of the jetty head to withstand the principal berthing blows. These together with the

New Oilport at the Isle-of-Grain—continued

jetty head were designed on a basis of a 32,000 ton tanker striking the fenders at a velocity of 0.8-ft. per second. It was assumed that 40 per cent. of this kinetic energy would be absorbed by the fenders with only three of the fender units taking the blow. The units consist of a steel box girder 3-ft. wide x 1-ft. 8-in. deep extending from deck level downwards for 26-ft. 10-in. Bolted on the steel girders are three timber rubbing strips 12-in. x 8-in. each. This

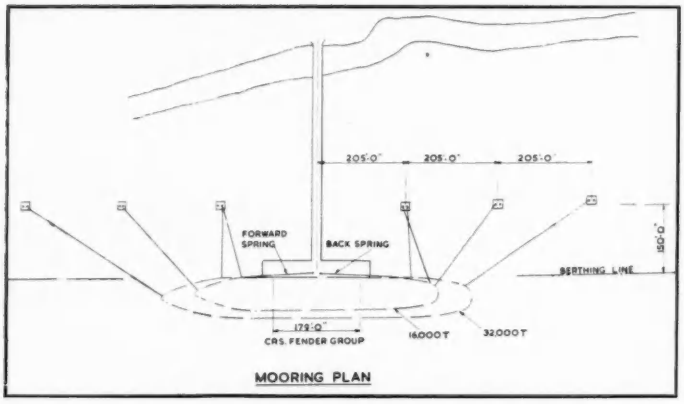


Fig. 10.

unit bears against three rubber blocks placed at 6-ft. 6-in., 18-ft. 6-in. and 23-ft. 3-in. below the deck level, the central block coinciding with the lower deck level. Each rubber block is 27-in. long x 12-in. wide x 18-in. deep with a total compression of 9-in. under a load of 100 tons, and was installed with a precompression of 2-in. (Fig. 9). The total energy absorption capacity of one complete fender unit is 75-ft. tons with a permissible travel of 7-in. At the time of installation it is believed that these were the biggest rubber fender blocks in use in the United Kingdom. In the case of No. 1 Jetty no movable fender units are provided but timber rubbing strips only along the face of the jetty. The design of the jetty is such that the impact of vessels is absorbed by the jetty itself being of a semi-rigid construction.

Moorings.

The principal mooring points apart from those on the jetty head, take the form of shore bollard blocks or isolated dolphins according to the distance from the shore (Fig. 1). Each block accommodates two bollards and is designed to withstand a total maximum force of 100 tons when both bollards are in use. The block is situated on the front face of the sea wall and is tied back to two concrete anchors. The dolphins are single-deck concrete structures supported on vertical and raking tubular steel piles, each dolphin accommodating two bollards (Fig. 4). A typical mooring plan for tankers berthed at Nos. 6 and 7 Jetties is shown in Fig. 10.

Corrosion.

A considerable amount of thought was given to the effect of corrosion on the steel piles, as evidence was available from the existing steel jetty structures that corrosion was likely to be fairly heavy. The piles were treated on all jetties except No. 1 with a priming coat and then one coat of cold applied coal tar enamel, the priming coat being applied at the works after the surface had been prepared by sand blasting. In the case of No. 1 Jetty a final coat of hot applied coal tar enamel was used. It has been found that the wearing properties of the cold applied enamel are poor under the conditions prevailing on the Medway; the piles being denuded of paint between "wind and water" within a year. More success has, however, been achieved by the application of two coats of this enamel, as well as with the hot application. Due to the doubtful wearing quality of the coatings, it was decided to provide cathodic protection by means of impressed current. The electrical supply for this system is provided by transformer-rectifiers installed on the foreshore near the jetty approach. The D.C. output capacity of these units is 12 kw. for the main jetties and 8 kw. for No. 1 Jetty at a maximum voltage of 40 volts in each case, giving an approximate current density of 6 m/amps/s.f. A groundbed consisting of a series of graphite anodes is buried in the foreshore and connected to the positive lead of the transformer-rectifier. The negative side is connected to the terminal plate on the jetty; all piles are bonded to this plate in series parallel. Provision has also been made to bond a tanker to this system when alongside the jetty. Insulating flanges have been provided in the jetty pipework at the shore end of the jetty to insulate this pipework from the refinery.

Jetty for Lubricating Oils.

The Lubricating Oil Jetty has been designed to handle lubricating oils both in bulk and drum packages which are to be loaded into barges and small coastal craft, it being possible to berth up to 2—500 ton barges or one 1,000 ton tanker on either jetty face at any one time. In order to facilitate the handling of drum packages, unrestricted access has been provided along the shore arm and jetty head. The pipework has been taken on cantilever supports on one side of the shore arm and then ramped down onto a lower deck at the jetty head where manifolds are provided over which are flush fitting covers on the upper deck for easy access and delivery of bulk cargoes.

Construction.

It was decided to use Larssen B.P.4 piles driven to a specified set into the gravel layer, the length of piles varying from 80 to 110-ft. Due to the small berthing impacts to be catered for all the piles are vertical with the exception of eight which are raked at $2\frac{1}{2}$: 1. The construction of this jetty was facilitated by the use of considerable pre-cast work. On each pile bent, consisting of two piles each, a pre-cast slab, which had been cast upon two concrete muffs, was placed, accurately levelled and grouted up. The intermediate panels were then cast *in situ* and formed the completed deck (Fig. 11). The walls and top deck of the jetty head are of cast *in situ* construction. Protection against berthing

Fig. 11. Showing the precast concrete slabs with cantilever supports in position and the reinforcement being fixed for the cast in-situ section.

blows is provided by 12-in. x 12-in. mild steel broad flanged beam fender piles.

Costs.

The total cost of construction of these jetties, excluding the pipe work, hose handling cranes and electrical installation is estimated at £1,500,000 approximately. Jetties 2 and 3 were considerably cheaper than Jetties 6 and 7 where the shore arms were longer and dolphins had to be adopted rather than shore mooring blocks, the costs for two jetties being £470,000 and £676,000 respectively.

The consulting engineers for all the jetty structures were Messrs. Rendel, Palmer & Tritton, who acted in consultation with the Company's Engineering Division. The Contractors for these works were Sir Robert McAlpine (South Wales), Ltd., and for the dredging were the Westminster Dredging Co., Ltd.

Hydraulics Research

Progress Report for 1953

The report* of the Hydraulics Research Board (D.S.I.R.) and the report of the Director of Hydraulics Research, which are included in this publication, describe the progress which is being made in the building of the Hydraulics Research Station at Wallingford and the research work which has been carried on in 1953.

The first stage of the construction of the Main Hall has advanced during the year. A section of the Hall having a floor area of 300-ft. by 200-ft. is expected to be completed and ready for use in early 1955. At the time the report was prepared roof trusses were being erected.

A second wave basin, 120-ft. by 80-ft. by 2-ft. 6-in., came into use during the summer. It is equipped with a large reversible circulating pump with a discharge of up to 74 cu. ft. per second for the development of tidal currents in coastal models.

Research on the Effects of the Severn Barrage.

One of the models which will be constructed in the Main Hall will be a large model of the Severn estuary on which the effects of the Severn Barrage on the estuary can be studied. A pilot model of the estuary constructed to scales of 1/8500 : 1/200 is being used for preliminary investigations to determine a satisfactory seaward limit for the large model.

The East Coast Storm-Surge and Floods of 1953.

Two survey parties were sent from the Hydraulics Research Station to inspect the damage to sea defences and beaches. On the 3rd, 4th, 5th and 6th February, the following places were visited:—

Kent: Margate, Reculver, Herne Bay.
Suffolk: Jaywick, Clacton-on-Sea, Felixstowe, Aldeburgh, Southwold, Kessingland, Lowestoft.
Norfolk: Great Yarmouth, Sea Palling, Cley-next-the-Sea, Hunstanton.
Lincolnshire: Skegness, Ingoldmells, Mablethorpe.
Yorkshire: Spurn Head, Easington, Withernsea, Hornsea, Scarborough.

The main objects of the survey—which was necessarily somewhat hurried—were to study the effects of wave action and to take photographs (a) of the damage to sea walls before repair work had started, and (b) of the beaches before a return to normal weather conditions had wholly or partially obliterated the effects of the storm. Rough measurements were also made, and local accounts of the storm and its effects were recorded. From a study of the photographs and from comparative observations at the places visited, five generalisations have been framed:—

(i) In some places the damage and flooding can be attributed to simple over-topping of the sea-walls or banks on account of the abnormally H.W. levels. In other places, because of the H.W. levels, waves that would normally have broken hundreds of feet from the shore reached the sea defences and attacked them at a level higher than that for which they had been designed to withstand such attack, and breaching of the walls resulted.

(ii) When breaching of the walls by waves occurred in this way, it seems that, in general, the top decking or platform was cracked or blown off by pressures exerted through faulty construction joints. When this had occurred in one area, the unprotected filling of the wall, usually of sand or clay, could be washed away, leaving the whole wall in such a weakened condition that it could be almost completely demolished by direct wave action.

(iii) At the places in Yorkshire, Lincolnshire and north Norfolk where serious damage occurred, very little, if any, scour took place on the beaches immediately in front of the walls, and none of the walls inspected failed through undermining or scour of this kind, a common cause of failure during what might be called "normal" winter storms. In places, indeed, a certain amount of accretion seems to have taken place. Up to 6-ft. or 8-ft. of scour was observed on certain beaches, but not on those where the walls were breached or where flooding was serious.

In south Norfolk, Suffolk and Essex, changes seem to be typified by what happened at Aldeburgh, where beach material was everywhere moved towards the land. Where there was only a shingle bank, its front face was eroded and the material was spread over into the marsh behind it; but where there was a sea wall the beach was built up to a considerable height against it.

On the North Kent coast conditions of erosion were more common, notably at Margate where the lighthouse fell seawards and at Herne Bay where a large slip of the cliff suggests that weight had been taken off its toe.

(iv) The present-day cost of a substantial sea wall may be between £20 and £50 per running foot, and the higher the wall the greater the cost. It may therefore be considered uneconomic to construct or reconstruct many sea walls to such a height that they would certainly prevent large-scale flooding under such unusual conditions as those that occurred on the 31st January, 1953. If this is so, it would appear that all new or reconstructed sea walls should, in freak storms, be able to allow the sea to pass over them without themselves being damaged or destroyed. It is known that certain walls withstood the storm in this way. The requirement is important in any case, as there is no reason for supposing that a more severe storm with higher water levels will not occur at some time in the future.

(v) It may be thought that the rarity of this type of flooding in the past indicates that the levels of the walls in most places were adequate. Clearly the height of a wall must be governed by what lies behind it, and in some cases towns and caravan sites which had recently been constructed on uninhabited land protected only by low walls or banks were flooded.

Experiments in the Thames Pilot Model.

At the request of the Waverley Flood Committee, appointed to consider what steps should be taken as a result of the flood disaster, the Director undertook to conduct experiments on the Thames Pilot Model to investigate several controversial points connected with flood protection in the Thames Estuary. The first matter to be studied was the magnitude of the effect which an upland freshwater flood might have in raising storm-surge tidal levels in London, should such a surge coincide with an upland flood. The storm-surge which occurred on the 31st January-1st February, 1953, was therefore reproduced in the model by using an appropriate tide chart in the pneumatic tide generator. The fresh-water river flow at Teddington Weir was adjusted to represent a flow of 1,400 m.g.d. (2,597 cusecs) in the prototype (which was the flow taking place at the time of the storm), and H.W. level in London was recorded. Using data supplied by the Thames Conservancy, the fresh-water flow was gradually increased to a flood of 20,000 cusecs, a figure which has rarely been exceeded. The storm-surge was arranged to coincide with the 20,000 cusec peak of the flood, and the H.W. level at London Bridge was again recorded. This experiment was carried out five times with closely similar results, and the mean of the five readings was calculated. This showed that the H.W. level in London would have been 0.75-ft. (9-in.) higher than the level actually attained, had the storm surge coincided with a major fresh-water flood.

Previous estimates by the Thames Conservancy, Dr. A. T. Doodson and the P.L.A. Engineer (1929) are in substantial agreement with these results.

Tilbury Tidal Basin.

The Tidal Basin leading from Gravesend Reach to the eastern lock entrance of Tilbury Docks is subject to heavy siltation, requiring an annual dredging of 400,000 cu. yd. Investigations into the causes and remedies have been carried out partly in the Thames Tidal Model, and partly by field work at Tilbury. It has been determined that there is a marked flow, on the flood, of bed water into the basin, accompanied by an outflow of surface water. At certain periods on the flood, the bed water contained a concentration of suspended solids of between 61,700 p.p.m. and 40,900 p.p.m. The conditions has been designated as "fluid mud." It is thought that the condition of the bed water is largely responsible for the heavy siltation.

*"Hydraulics Research 1953," H.M.S.O. for D.S.I.R., price 7s. 6d. (1 dollar 70 cents U.S.A.), by post 7s. 8d.

Hydraulics Research—*continued*

A number of schemes to modify the flow pattern of bottom and surface water in the Basin have been tried. Scheme No 27, illustrated in Fig. 1, produced a slow inflow of water into the Basin at all levels and prevented circulation completely. The Scheme consists of a vertical wall, probably of sheet steel piling, closing off the western, unused, portion of the Basin and a jetty, sheeted from bed to surface to prevent any through flow running slightly east of north from the eastern side of the Basin entrance. The area west of the sheet pile wall would be filled with dredged material and reclaimed. The Scheme also calls for the demolition of the derelict western jetty at the Basin entrance.

Experiments to determine the effect of Scheme 27 on siltation in the Basin have shown a very substantial reduction in silt deposited. The Report, however, emphasises that the results of this part of the investigation are qualitative only, and that further research and field work are required to evaluate the saving to be expected from the adoption of this Scheme.

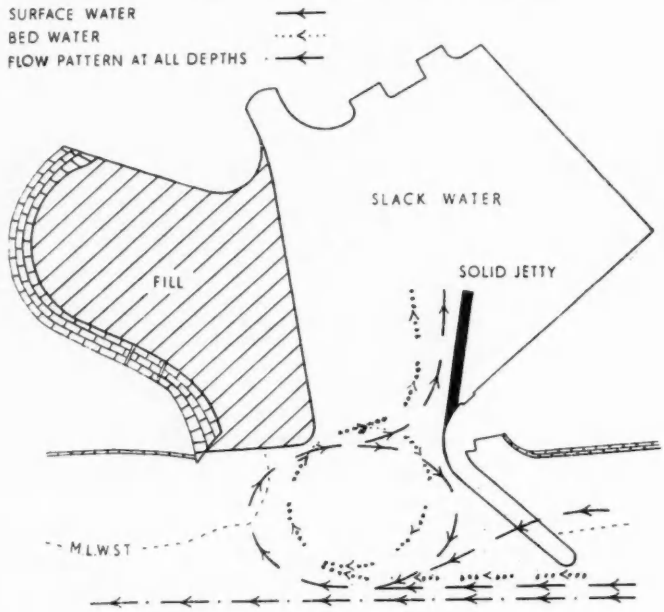


Fig. 1. Tilbury Basin Flow Pattern—Scheme 27.

The Impounding Pumps at Tilbury Docks.

The average dredging in the Docks since 1910 is 300,000 cu. yd. per annum. Analysis of the suspended solids in the intake water indicate that the highest concentration of solids coincides with the first half of the normal pumping period (from 3 h. before H.W. to 3 h. after H.W). This, however, did not account for more than one-seventh of the total siltation in the Docks which was found to be mainly caused by the ingress of "fluid mud" during the run-in to the docks which has hitherto taken the place of pumping on 2-3 days out of every 14 days. The accumulation of mud at the entrance to the impounding culvert is also held to be partly responsible. These questions are now being investigated, but it seems in any case advisable to dredge the mud of the Basin to a depth of about 10-ft. below the invert of the culvert.

Lyttelton Harbour Models.

The study now being made of Lyttelton Harbour, New Zealand, is an example of the work carried out at the Hydraulics Research Station for Commonwealth countries. The object of the work is to judge the relative merits of different designs of extensions to the present harbour from the point of view of the protection they afford, their susceptibility to ranging and the amount of dredging required to keep them open.

Two models are being used. One is a model of the whole tidal inlet to scales of 1/600 horizontally and 1/100 vertically in which both waves and tides can be reproduced. The other is a model of the inner harbour to scales of 1/100 horizontally and 1/90 vertically on which wave disturbance in the harbour is studied. When the analysis of wave heights in the present harbour is completed the tidal inlet model will be modified by adding the harbour extensions proposed by the Lyttelton Harbour Board. The dredging required to keep the harbour open will then be determined experimentally.

Wave Excluder for Dekhelia Power Station, Cyprus.

At the request of the consulting engineers responsible for the construction of a thermal power station near the sea at Dekhelia, Cyprus, the Hydraulics Research Station carried out an investigation to find a way of preventing waves from entering a discharge channel for cooling water.

Under certain conditions of wind and tide it was found that waves travelled up the channel, and broke at its upper end. The splashes from breaking waves caused considerable corrosion of the steel structure of the station.

After a series of experiments had been carried out on a model built to 1/9 scale a completely satisfactory remedy was found. It consisted of installing in the channel a weir block made of concrete. The standing wave caused by the weir acted as a barrier to incoming waves and prevented them from passing up the channel.

An Electronic Current Meter.

A sensitive current meter for measuring a wide range of water velocities in models has been developed at the Station. A small propeller seemed to be suitable for the purpose, provided that a means of timing could be devised which did not interfere with its rotation. This was achieved by supporting the plastic propeller on a stainless steel rod which forms one electrode of an electrical circuit. The second electrode is provided by a gold wire mounted radially to, and just clear of, the propeller. Under these conditions the movement of a foreign body (in this case each propeller blade) across the conducting face of the gold electrode causes a change in the conductance between the two electrodes. Two separate timing devices have been developed to use this principle. One is a dekatron counter and timer, the other an electronic tachometer. By these methods it is possible to measure water velocities as low as one quarter of an inch a second.

Publications Received

Gravity Waves: Tables of Functions

The Council on Wave Research, Berkeley, California, has recently published a useful set of tables of the Functions of Gravity Waves which is obtainable from the above address, price $1.00. These have been compiled by Robert L. Wiegel, who states in his Introduction that engineers and scientists who deal with problems connected with gravity waves in oceans, lakes, reservoirs and harbours often find it necessary to make certain calculations which involve the wave length, wave period and water depth. The purpose of the publication is to assemble for easy accessibility some of the more frequently used tabulated functions.

There are three principal tables. Table I gives the various relationships as functions of depth/wave length for even increments of depth over the deep water wave length. Table II gives the relationships as functions of depth over the wave length at that depth. Table III, "Deep Water Wave Length and Velocity" gives values for velocity both in feet per second and in knots and corresponding wave lengths for periods ranging from 0.5 sec. to 26.4 sec.

These tables would seem to fill a real need, inasmuch as, although the equations from which the tables have been constructed have been widely known for many years, there does not appear to be in existence any compilation of results which is available to harbour engineers and others.

Bulk Cargo Handling

Description of Some Modern Mechanical Installations

By ROBERT S. LEWIS, Conveyor Engineer Hewitt-Robins, Inc.

THE problem of the rapid handling of bulk materials in port installations has been highlighted by America's search for new high-grade iron ore. Stimulated by the forecast of dwindling yields from domestic sources, the search has become world wide, and has centred on areas where it can be made economically feasible to transport the ore to ships and thence to processing plants in the United States.

Experience in conveyor transportation under the space restrictions encountered in mines and power plants has contributed greatly to the know-how of developing facilities for loading and unloading ships under the conditions imposed by limited dock sites. Improved belts, bridges, stackers, towers, trippers, booms and trimmers have greatly reduced the in-port time of cargo ships.

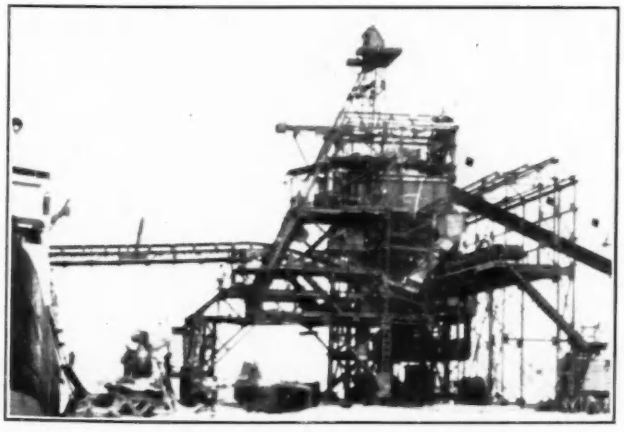
The primary problem in reducing turn-round time is that the bulk material must not only be brought to the dock site in large quantities and handled at a rapid rate, but that the port installation must be able, between ship loadings, to store the continuing influx of material in preparation for rapid loading of the next vessel.

The basic layout required for bulk loading installations includes:

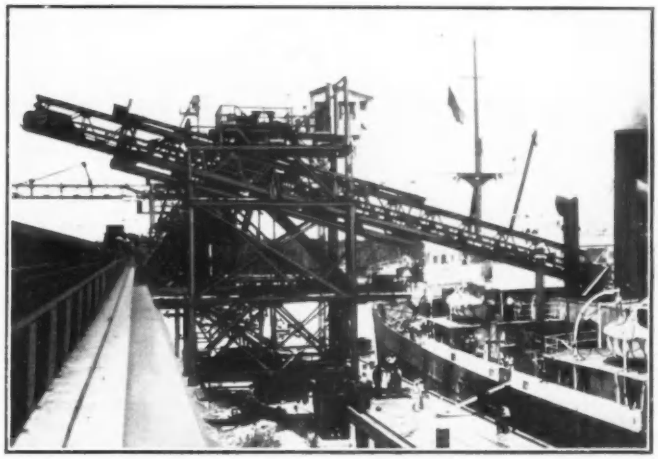
1. **Railroad car unloading facilities,** to unload cars singly or in groups and transfer the material into stowage at the dock site.
2. **Storing equipment,** including a stacker or other means of depositing the material in convenient arrangement.
3. **Equipment for reclaiming,** or removing from storage. This may include power shovels or buckets and travelling hopper cars or tunnel conveyors.
4. **A tower** with weighing equipment and appropriate boom conveyor for loading the material into the ship.

In unloading ships, the order of processes is reversed, and special unloading equipment is also required.

1. **An unloading tower** equipped to remove material from the holds of ships.
2. **A tail track** extending past the loading point a sufficient distance to allow a string of cars to be backed onto the dock and loaded in continuous sequence.
3. **Car loading facilities,** including means of accurately weighing the ores for customs reports. Where accuracy within approximately 1½ per cent. is sufficient, weightometers are most convenient.
4. **Storage facilities** to handle material not immediately removed in ore cars.



Movable Tower straddling car rails at Conakry installation. Rails pass along the fill beside the storage pile, and thence between legs of loading tower to dockside.



A Rope-operated Shuttle Boom loading a ship at the Alabama State Dock Commission's installation at Mobile, Alabama. The raised position of the control cab gives the operator a clear view.

Among the earliest ore port installations were those at Port of Spain, Trinidad; Takoradi, West Africa, and Minas del Rif, Morocco. New or improved port installations incorporating the most recent practices include Conakry, French West Africa; Monrovia, Liberia; Guayacan Bay, Chile; Mobile, Alabama; and the Canton pier in Baltimore, Maryland.

The Conakry harbour installation is interesting for its entirely new bulk loading system, built on a man-made supporting peninsula which juts out to deep water. This peninsula had to be constructed substantial enough to sustain the weight of the large iron storage piles.

The loading system, which includes thirty-seven bins and gates, handles 1,375 tons of ore an hour on seven belt conveyors, totalling almost a mile of belt. A travelling stacker and a travelling tower are employed for storage and ship loading. These are controlled electrically from a station in the surge bin building and another in the tower. All conveyors are electrically interlocked and can be operated on a fully automatic circuit.

Booms

Loading speed is an important factor to reckon with in handling bulk materials. Belt conveyors mounted on movable booms have proved to be the most effective way of solving this problem. Not only do they load at rates far surpassing those possible by other methods, but in handling such large quantities their cost per ton is substantially lower. Naturally, sufficient quantity must be involved to warrant the initial installation cost, and the loading rate requirements must be at least in the hundreds of tons per hour category.

A variety of booms are employed depending on the requirements of the vessels to be loaded, the space limitations of the port or pier, and the tides in the particular port. Hinged booms are designed to move up and down, and frequently house in a vertical position. Shuttles move in and out horizontally, and are often also hinged. Either type can be provided with an extensible section.

Where tide ranges are small, and the only consideration is for getting the boom out of the way so a boat can move, a shuttle boom moving horizontally can be used. An example of such a boom is the installation at the Alabama State Docks at Mobile, or the shuttle boom used at Monrovia.

Where tides are substantial, a hinged boom is required complete with the necessary hoists and tower superstructure to position

Bulk Cargo Handling—continued

Revolving Trimmer Chute at Texas Gulf Sulphur Co.'s loading pier No. 34 at Galveston, Texas.

it or raise it clear of the dock line to enable vessels to move alongside without interference. These booms can be housed firmly enough in their vertical position to resist hurricane winds, or allow the repair, removal or replacement of cables when necessary.

Vertically housing booms can also be designed with an extensible section similar to the shuttle booms, operating through a rack and pinion so that the effective length of the boom may be increased by 10 to 30-ft. This extensible section can thus be used like a shuttle to aid in trimming the load. An example of such an installation is that at Puerto de Hierro, Venezuela.

Such hinged booms can discharge materials at levels of as much as a third of a boom length above or below the hinge point, although generally an 18° angle up or down is the desirable limitation. This manoeuvrability allows the boom to accommodate a variety of loading chutes with convenience.

Trimmer Chutes.

In order to reduce degradation, distribute cargo, trim ship, or minimise dust hazards, chutes are often required at the discharge end of the boom where they can swing in and out, telescope up and down, or revolve full circle. In housed position, they are often pulled in to rest parallel with the vertical boom, as in the Conakry installation. Several other interesting features are illustrated in this installation; for example, the hood cover for the boom; the anemometer, at the top of the tower, electrically interlocked to prevent the boom from operating in wind greater than 30 miles per hour; and the built-in weightometer.

Another type of chute, originally designed for loading and trimming river barges and capable of handling 1,250 tons of coal per hour, is illustrated in the Ford, Illinois, installation. Here, the chute is designed to remain always at the same angle to the ship, regardless of the angle of the boom.

A revolving trimmer chute is used at Texas Gulf Sulphur Company's loading pier No. 34 at Galveston, Texas. This chute not only revolves 360°, but swings back and forth in the plane of the boom to trim the load, and extends down to minimise dust. However, it can be shortened to adapt for ship loading, by removing sections. It is made of aluminium to reduce the danger of electrostatic sparks which might cause the sulphur dust to explode. The boom can be latched and housed, with the trimmer chute resting parallel to the boom.

Towers and Tracks.

The booms are supported from fixed or movable towers, depending on the traffic to be serviced. Movable towers facilitate loading, since the ship does not have to be moved to fill all holds, but there must be sufficient tonnage to warrant such an installation. A twin boom loads coal from a fixed tower at Havana, Illinois, and the barges move back and forth beneath it to be loaded. The twin boom is necessitated by the extremely high rate of tonnage (3,600 tons per hour) of coal that must be handled. The trimming chute hangs in a vertical position and is moved back and forth crosswise of the barge by a motorised drive to provide maximum and even loading. Where a bulk handling pier must also handle mixed cargo, including packages, crates and bales of freight, provision must be made to get railroad cars to the dockside. The railroad cars must pass over or under or through the conveyor system in order to be in the most favourable loading position, which is between the dock conveyor and the ship. In the Conakry installation, the rails for the cars pass out along the fill beside the storage pile, and then pass between the legs of the loading tower, running parallel with the rails upon which the tower moves. However, such a system must be modified to the peculiarities of each installation and plant layout.

Balancing Bins.

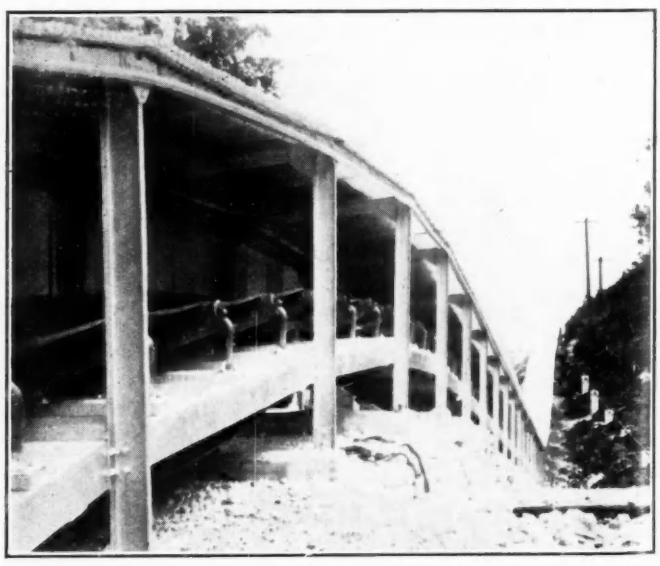
Continuous flow of material is necessary to attain the high average tonnage rates desirable in port loading. Such continuous flow is maintained even while the boom is traversing hatches, through the use of balancing bins located near the loading tower. These bins cushion the flow of material, thus eliminating momentary stoppages of the system.

Overland Conveyors.

Where as much as 20,000 tons per week is to be loaded continuously, and mines or quarries are located within 10 miles of the dock, overland conveyors may be feasible to transport material directly from the mine to dockside storage. Because of the lower costs compared with rail or truck, which require tracks and roads, the conveyor is becoming increasingly favoured as a method of transportation. Such an overland system is used in the West Indies at Kingston, Jamaica, where both uphill and downhill sections are powered by a single unique drive mechanism, developed by Hewitt-Robins' engineers. Ordinarily, such a conveyor is run by separate drives for the inclined and declined sections, but in this case, a single motor, connected to two drive pulleys through overriding clutches, provides a patented method of driving the uphill section and retarding the downhill sections with a single, less expensive drive.

Tripper Trailers.

Since ships rise higher than the dock, and since loading booms must rise higher than the ship, material travelling toward the dock



Conveyors. When mines or quarries are located close to ports, it is sometimes feasible to use overland conveyors to bring the ore to dockside as in this system at Kingston, Jamaica, B.W.I.

Bulk Cargo Handling—continued

must be sufficiently elevated to discharge onto the boom conveyor. Where an elevated or high line conveyor brings material to the dock, it can discharge directly onto the boom. Where the belt conveyor to the tower moves at dock level, a tripper trailer is usually used to elevate the material high enough to discharge onto the boom conveyor. A typical tripper trailer is that used in the installation at Monrovia. This unit delivers to a shuttle conveyor mounted on a boom supported by cables at the discharge end, with the other end extending well out on the landward side, thus providing ample reserve length for the servicing of all size ships, including the new large ore carriers.

Since tripper trailers convey at a maximum angle of about 18°, they require a dock length of approximately three times the maximum height to which material is elevated. This additional dock length, however, involves the extra requirements of adequate piling, reinforced concrete, and additional fill, and therefore a high line is to be preferred in some cases.

Storage.

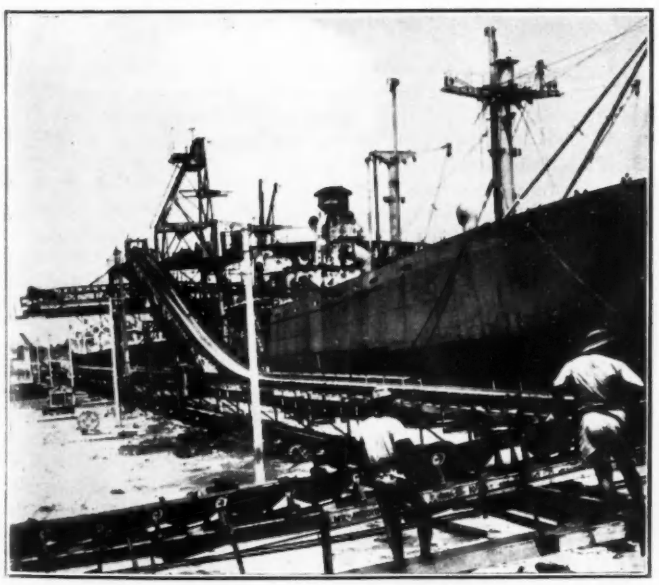
Sufficient dock site storage at the port is necessary to balance continuous mining against intermittent ship loading. The ore, which is generally transported from mine to port by rail and deposited into storage at approximately the same tonnage rate as the mine production, is relaimed from storage for ship loading at a very much higher rate, to reduce loading time to a minimum. The necessary storage area will be determined by the number of ships to be loaded in a given time, and by the depth to which the material can be stored on the terrain. Where possible, it is advisable to store material on both sides of the reclaiming belt, where power shovels are used to reclaim, and on both sides of the stacker belt where tunnels are used for reclaiming.

Stackers.

Stackers discharge ore onto a storage pile. The stacker at Liberia, for example, discharges crushed ore, and traverses continuously between set limits, thus building up an even pile entirely automatically. Stacker booms can be fixed or movable. Horizontal or "slewing" motion increases storage volume. Vertical motion allows the boom to be kept close to the pile, reducing dust and minimising degradation.

Tunnels.

Reclaiming from storage piles is frequently handled by a conveyor running in a tunnel beneath the storage pile. The tunnel top has a series of openings along its length, each with a gate or feeder to control the rate of flow to the tunnel conveyor. Occasionally, hydraulically operated gates or vibrating feeders are used for more automatic operation. Although such conveyors are a great advantage, they are limited in that they can only be installed where they will be above ground-water level, or can otherwise be kept dry.



Ore at Monrovia moves on conveyor in foreground from storage to dock conveyor, up tripper trailer onto shuttle boom of loading tower. Shuttle conveyor boom is retractable for trimming hatches, and is hinged in the middle to accommodate ship height and tide levels.

Unloading. Aerial view of Canton Railroad Ore Pier in Baltimore Harbour. High line conveyor (left) moves ore from unloading tower at end of pier to balancing bin and weigh station (buildings in foreground). Ore cars are backed onto pier, then loaded continuously as they move out under loading point at weigh station.

Ordinarily, approximately half of a storage pile is "live" storage which moves out directly when the gates are opened. If the pile is restricted in space or of a valuable nature, so that the whole pile must be removed from storage to cargo, bulldozers or similar equipment are required to move the dead storage.

Firmness of the supporting ground is a factor in determining the height of storage piles and the type of tracks that can be used. When the ground will not support large bearing loads, storage piles must be kept low, and in most cases this kind of ground also means that tunnels must be replaced with steam shovels or drag lines loading a hopper car which moves on rails above the stacker belt. Its rate of feed controls the flow to the main belt. These cars can be designed to receive either from a storage pile or from a stacker operating on the same belt.

Here again the soil bearing pressures must be taken into account. When ground conditions are inadequate for tunnels and require that storage piles be returned by hopper cars and shovels, they usually also require special consideration for the laying of track. Frequently, one pair of rails will concentrate the weight too much for poor ground, and the weight must be spread to four. The installation at Monrovia uses four rails.

Ore Cars.

At Liberia, ore cars are unloaded singly, one after the other, into a feeder equipped hopper which loads the trunk line belt conveyor. (In such a single-car operation, car-shakeouts are often used to advantage, particularly with low grade or fine ores which tend to "hang up" in the hoppers).

The Conakry installation features a more rapid method of unloading into storage. There, 20 cars are unloaded simultaneously into an equal number of hoppers spaced beneath. Thus a group of cars can return to the mine for another haul with a minimum of lost time at the discharge end. The hoppers beneath the cars

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Permanent International Association of Navigation Congresses

Annual Report of the British National Committee, 1953-1954

The XVIII International Congress was held in Rome from September 15 to 22, 1953, and among the many papers presented and discussed at the meeting, six were by members of the British section*. The papers were all very interesting, but the method of presenting them by the reporters introducing the summaries and criticisms, which could have been taken as read, tended to shorten discussion.

While in Rome the delegates and their ladies were entertained to banquets, receptions, visits to the city and surroundings, by the Italian Government and the Municipality of Rome.

Visits to the river works on the Tiber at Fiumucino and beach protective works at Ostia (with glimpses at the old town of Ostia) were enjoyable and instructive.

On the conclusion of the Congress the Port of Naples was visited, including the up-to-date maritime station passenger terminus and a graving dock under construction. Visits were also arranged to places of interest near Naples, including Vesuvius, Pompei, Capri and Sorrento.

Afterwards the party split, one portion going on to Genoa to visit the port and environment, and the other to Venice to see the industrial port of Marghera and Venice itself, and also to the hydro-electric works on the Piave and Contini, with alternate visits to the extensive river works on the Po, and the Venice Estuary.

Work on the International Technical Dictionary has continued during the years between the Congresses. Mr. Nachshen, the British member of the Dictionary Committee, has prepared the English text of the forthcoming Chapter VI on " Water and the Sea " from the French original.

Arising out of the discussion at the Rome Congress in 1954, the Secretary General of the International Association requested the British National Committee to co-operate with Colonel Falkner, the Secretary of the American Section, in the preparation of a comparison of methods adopted for loading general cargo in European and American ports and the rates of loading achieved. The Committee received memoranda prepared on this subject from the British Transport Commission ports, the Manchester Ship Canal Co., the Mersey Docks and Harbour Board, and the Port of London Authority, and these were forwarded to Colonel Falkner. While it has been stated that the figures given should not be used for comparison between ports because of the wide variation in operating conditions, it is interesting to note that differences were less than expected and this average figure for discharging general cargo is of the order of 15 tons per ship-gang-hour and for loading 10 tons per ship-gang-hour. It seems probable that the investigation is an attempt to assess the relative merits of the European method of using quay cranes and the American custom of employing ships' gear, and the resulting paper should be instructive.

It is unfortunate that little progress has been made by the special Committee on Depths in Sea Ports, which was set up last year. The Committee appointed four panels to consider the problem under the following headings:—

(1) The types of ships required by shipowners and the reasons which dictate the requirements.

(2) Tendencies in the design of ships and any structural limitations or developments.

(3) The design of port works required to meet changing ship dimensions.

(4) The economic effects of these changes on shipowners and ports.

The problems have proved to be difficult, but it is already clear that there is a tendency to increase draft, for example, the draft of Far Eastern passenger liners is now 32-ft., an increase of 4-ft. in approximately 20 years. It is hoped that a useful statement will be produced and it has been noted that the report of the Dominions Royal Commission in 1917 provides a review of facilities at that time and forecasts for the future, which can be used as the basis for a valuable comparison. The American Section of the Permanent International Association of Navigation Congresses has already produced its report† which contains information on current tendencies in th design of liners, cargo ships, tankers and bulk carriers.

There has been during the year no significant increase in the membership of the British Section, which continues to be small in comparison with other countries, as the following figures show: U.S.A. 635; France 241; Netherlands 156; Spain 155; Italy 133; Belgium 132; Great Britain 62.

The Committee wish to impress on members the necessity of increasing the membership substantially so that it may be more in keeping with this country's maritime interests, and encourage others to join the British Section.

The arrangement whereby The Institution of Civil Engineers provides, without charge, the Secretarial facilities for the British Section, and accepts payment of subscriptions for onward transmission to Brussels, has continued during the year.

Particulars of the Association, of the British Section, and application forms, are available from the Secretary of the British Section, P.I.A.N.C., c/o The Institution of Civil Engineers, Great George Street, London, S.W.1.

*An account of the impressions of some British members who attended the Congress was published in the December 1953 issue of this Journal.

†A review of this Report appeared in the November 1953 issue.

The St. Lawrence Power and Seaway Project.

The New York State Power Authority has received permission from the United States Supreme Court to go ahead with its hydro-electric power scheme on the St. Lawrence River. The Power Authority sought immediate action in the case so that construction of the New York-Canadian power plant and the St. Lawrence Seaway could be started in July. The Canadian Government has been urging the need for speed, stressing the scheme's importance to defence. The opponents of the project were the Lake Ontario Land Development and Beach Protection Association, who claimed that raising the water level would injure their property.

As far as the Seaway is concerned, a member of the U.S.A. House of Representatives has announced his intention of asking that the United States Army should examine the possibility of a canal to link the proposed St. Lawrence Seaway and the River Hudson. The canal, which would provide a waterway between New York and the Great Lakes as an alternative to the present land route of 1,500 miles, would run from the Hudson through Lake Champlain and the River Richelieu to the St. Lawrence.

Bulk Cargo Handling—continued

act also as storage or surge bins and balance out the heavy intermittent discharge into a uniform flow onto the conveyor belt by means of control gates.

Where high tonnage capacity is required, and the cars are plain bottomed instead of gondola-type, a car dumper is sometimes used. However, loading rates exceeding 1,000 tons per hour can be maintained without the use of a car dumper.

Unloading Stations.

In the shipping business, it is as important to reduce turn-round time at unloading installations as it is at loading points.

The Canton ore pier at Baltimore, Maryland, is an excellent example of modern high capacity unloading facilities. Here, ore boats from Liberia, Portuguese West Africa, Venezuela, and other foreign countries unload into railroad cars at a free digging rate of 3,000 tons per hour. In order to load continuously on any of the four tracks, a high line conveyor was installed, and car loading facilities were placed ashore beyond the pier in order to allow long strings of cars to be backed onto the pier, thus providing continuous loading. A high line conveyor moves along the dock inland to a balancing bin and weigh station at the point where the cars are loaded. The balancing bin is a bifurcated hopper arranged to direct material over each pair of tracks. Each of the lower openings is equipped with heavy-duty manganese feeders and Fairbanks Morse scales for batch weighing. A gallery-enclosed inclined conveyor lifts the material from the high-line conveyor to the bin. The unloading towers are so arranged that when small cargoes are unloaded, the material can be delivered directly to gondolas at ship side on either of two tracks.

Keeping Narrow Waterways Navigable

New Machines which Reduce Costs

By JOHN GRINDROD, B.A. (Com.).

All over the world millions of pounds are spent annually on the task of restoring and keeping free of weeds and silt small waterways and channels. Not only is this often necessary to provide navigation facilities, but also as a means of draining the surrounding land and keeping it free from surplus water. It is often essential also for irrigation purposes.

It is frequently found that the weeds and silt accumulate faster than clearing by manual labour can be maintained. The growing scarcity of labour for this type of work has been proving difficult in more recent years, while costs have increased enormously as a result of rising wages.

How to tackle this problem has been the subject of investigations in both England and the Netherlands. As a result, a number of machines have been produced which do the job quickly and efficiently and at reduced cost. Water weed cutting machines have been developed at Bedford, England, by the firm of Howard and Dennis, Limited, while miniature dredgers have been produced in the Netherlands, notably by the firm B. P. De Groot, Jr., of Weesp.

Weed Cutting Machines.

Now in use by many catchment and river boards and other authorities in the British Isles as well as in many other parts of the world, the weed clearing machines fulfil two major operations. They can be used for the initial clearing of badly overgrown areas and for the maintenance of clear water after the initial cutting has been completed. Both operations can be carried out by the same type of cutting launch. The correct procedure must, however, be adopted to get best results, the keynote of success being to cut frequently, never allowing the weed to get above the water surface. This constant cutting reduces the vitality of the weed and retards growth. Thus, each subsequent cut can be carried out at a speed greater than the last and large areas can be maintained at low cost.

Consisting of a shallow-draught, flat-bottomed hull with sloped ends, the launch, designed for this purpose, is installed with a power unit which drives the self - clearing propulsion gear and cutting mechanism. Of paddle-wheel type, the propulsion gear is fitted to the stern of the launch. Except in one model, the whole gear is hinged radially to enable it to act as a rudder and the power of the engine thus holds the boat against the side pull, enabling good control to be maintained under all conditions.

The cutting blades consist of a number of small tempered-steel sections riveted on spring steel backs. These are mounted in the form of a " Vee " on the end of an arm which is hinged at its inner end. The whole arm is controlled for its depth of cut in the water and is given a rapid oscillating motion which effectively cuts all weeds in its path. The angle of the blade is adjustable to suit the average depth at which the launch is operating. The blades are rigidly supported so that they can be maintained in a horizontal position at any depth. They can be lowered right on to the bed of the waterway, but since their weight can be sustained, they can be used so as not to sink too deeply into loose silt which would give unnecessary resistance.

Four standard type weed cutting launches are made: the " WD " type suitable for narrow, shallow waterways; the " B " type for general work either in quite narrow waterways or larger areas where the 8-ft. cutters can do useful work; the "GP" type, of wide application, which has a central cutter blade at the bow and twin cutters at the stern, each set being capable of independent operation. (Where heavy upstanding growths have to be dealt with the front cutter can be lowered to about 2-ft. to 2-ft. 6-in. depth to cut a passage for the hull to pass over, the twin rear cutters, which can take a 14-ft. wide cut, then being operated at the required depth); the " A " type for very heavy work, which operates with twin cutters only. Over the four standard types, hull dimensions range from length 16-ft., width 3-ft. 6-in., depth 16-in., draught 7-in., to length 22-ft. 9-in., width 6-ft. 2-in., depth 2-ft. 6-in., draught 14-in. Cutting speed is usually up to 3 m.p.h. according to conditions. In operation, the cutting arm is lowered by means of a small hand winch until the shoe rests on the bed of the waterway. As the arm is freely hinged at its inner end the cutters automatically follow the contour of the bed, adapting themselves from the shallowest water down to a maximum depth of 7-ft.

Where there is water movement, as on a river, the cut weeds are collected by temporary booms placed diagonally across the river below the point of cutting. Lifting out of the water can be done either by a floating elevator placed in the water or by a wheeled elevator working from the bank. In water which has no movement, the weeds can be left to drift to one area by the wind, or pushed to a definite collecting point by means of rakes attached to the launch.

" WD" type Launch.

Stream nearly cleared.

Clearing completed.

Units can be fitted with petrol or diesel engines, as desired, but since the lighter petrol engine reduces draught to a minimum, this is more often used for these shallow, weed-infested waters. Launching and transport trailers are also provided when required.

Keeping Narrow Waterways Navigable—continued

The quickly collapsible Midget Dredger is specially useful where low bridges have to be negotiated.

As well as the standard models for normal requirements, special machines are also produced to deal with particular types of weeds. For instance, machines have been developed for dealing with the Sudd growth, which is prevalent in southern parts of the Sudan and in Nigeria, where, in certain places, it grows to a depth of 20-ft. below water level. The machines cut out the Sudd in blocks, lift it from the water and deliver it either to the bank or into barges. Other machines have been produced for cutting such reeds as papyrus and phragmites as well as for hippo grass and such floating weeds as water hyacinth. All these special applications have, of course, to be dealt with to suit individual circumstances.

Where a number of the Howard and Dennis weed cutting machines have been in use in the Sudan, costs for cutting a given area have been 36s. compared with £8 for cutting with native labour.

Three Types of Small Dredgers.

Closely allied to these weed cutting launches for the purpose of providing and maintaining clear narrow waterways are the small-scale, one-man operated dredgers built at the Lilliput Works of B. P. de Groot, Jr., Weesp. The 30 standard models fall into one of three classes. Two of these are bucket type dredgers, while the third is a suction type dredger. In the case of the first of the digger bucket types, the discharged spoil from the buckets is diluted with water to enable it to flow readily along gravity discharge chutes.

Due to a special tumbling system, the whole ladder with buckets and the upper part of the main framing can be raised or lowered by the winches on this quickly collapsible Dredger.

The second digger bucket type is installed with a mud pump, by means of which the discharge from the buckets, when mixed with water, is forced through floating and fixed pipes to spoil areas up to 650-ft. from the dredger according to the power of the engine fitted and the height of the discharge. Used, generally, for the more sandy kind of water bed, the suction class of miniature dredgers also discharge the spoil by means of mud pumps. For heavier soils cutting nozzles are fixed to break up the soil in front of the suction nozzle. The capacities of these varying machines range from 850 cu. ft. to 5,000 cu. ft. discharge per hour. Power is provided by diesel engine.

Of the bucket dredgers, the smallest has an overall length of only 13-ft. 2-in. and a dredging depth of from 21½-in. to 59-in. It requires a minimum fairway of at least 8-ft. 3-in. in width. The second class of bucket dredger has an overall length of 16-ft. 5-in. and a dredging range of from 22-in. to 79-in. in a minimum fairway of 13-ft. 2-in. Bucket capacity is 610 cu. in. and maximum speed of operation is 40 buckets per minute, which is reduced to 18 when operating in heavy soil.

In the bucket class, the Weesp firm feature a new quickly collapsible dredge for special use in waterways where low fixed bridges have to be negotiated. The superstructure can be rapidly lowered from a total height of 13-ft. 9¼-in. to only 4-ft. 11-in. above water

The smallest in the range of the new Cabin Dredgers.

level. Instead of almost the entire superstructure having to be dismantled and afterwards re-erected as is the case with normal dredgers, the various parts of the collapsible lilliput dredger superstructure can be removed in very little time. Part of it can be sunk into the hull. Thanks to a special tumbling system, the whole ladder with the buckets, the upper part of the main framing and the upper tumbler fitted thereon can be raised or lowered at will by using the winches. With a length of 22-ft. 11½-in., width of 8-ft. 10-in., depth of 3-ft. 3-in. and draught about 1-ft. 7½-in., the 20 litre bucket capacity dredge can deal with 34 cubic yards per hour to a maximum dredging depth of 6-ft. 6¾-in. It can be operated by one man and transported by motor lorry.

Equally easily transportable by truck is a new streamlined lilliput suction dredger model ZP 15, with a modern closed-in cabin built on its deck, which forms one unit with the engine room. This smallest of a range of similar machines has a maximum hourly sand yield of 1,060 cu. ft. and can discharge to a maximum distance of 131-ft. The largest model of the range, ZP 35, has a capacity of 6,003 cu. ft. per hour and can discharge up to 2,624-ft.

In addition to the 30 standard models, the firm can construct almost any required type of dredge completely adapted to local conditions. They have also constructed a number of much larger machines, among which are bucket dredges with discharge pumps, and suction and cutter-suction dredges. The two latter are equipped with pipes of diameters up to 24-in. Bucket dredges have bucket capacities up to 400 litres.

Underwater Television

Application to Marine Salvage Operations and Repair of Damage to Ships and Structures

THE application of underwater television to the survey and repair of damage to ships and to salvage operations was the subject of a paper at the second day of the spring meeting of the Institution of Naval Architects in the H.Q.S. Wellington. The paper was presented jointly with the Institute of Marine Engineers, whose members had been invited to attend the meeting.

The author, Lieut.-Comdr. J. N. Bathurst, O.B.E., D.S.C., R.N., was introduced by Sir Charles Lillicrap, chairman of the Council, who said the institution and the Institute of Marine Engineers were always keen to collaborate on papers when the occasion was suitable.

The following are some excerpts from the paper.

Introduction

The use of television under water is a post-war development which is bound to revolutionise certain diving and marine salvage techniques. The value of its application to underwater work has long been realised, but it is only through the great progress made during and since the last war in underwater optics and various electronic techniques, that it has now become a practical proposition.

Much has already been written by scientists about the technical and scientific aspects of this equipment, in particular by W. R. Stamp, B.Sc., of the Royal Naval Scientific Service, who with his team has contributed an enormous amount to its development. To date, however, no authoritative attempt has been made to set forth the practical applications, and it is therefore the object of this paper to survey some of the uses to which the equipment has already been put, and to discuss some possible future applications.

The first successful use of television under water was achieved by the United States in 1947, and it was used by them in a static role at the Bikini atom bomb trials The National Research Council of Canada has also carried out several successful trials, but the first really practical test it received under operational conditions occurred in May, 1951, when it was used by H.M.S. *Reclaim* during the search for, and the subsequent survey, of H.M. Submarine *Affray*. This particular set, which was developed at very short notice by scientists of the Royal Naval Scientific Service, proved itself very reliable, and gave excellent results. The unqualified success of this equipment made it abundantly clear that underwater television had come to stay, and pointed the way to numerous other underwater applications.

Further research and development carried out since 1951 and which is still going on, has resulted in some remarkable progress being made, so that present-day equipment is as easy of technical maintenance and operation as other shipborne electronic equipment, such as radar. There is still need, however, for development in the methods of handling and controlling the underwater camera. This is mainly because the uses to which underwater television can be put are many and varied, and the handling arrangements and design of camera casings are largely governed by the type of work for which the set is required, and the conditions under which it will operate.

In addition to the research work carried out by the Royal Naval Scientific Service, several civilian firms manufacturing television equipment have also devoted much time and effort to the commercial development of underwater equipment.

The vast majority of television equipment used for underwater work to date has been the same as that used by the B.B.C. for broadcasting purposes, but incorporating certain minor modifications.

Some Basic Properties of Underwater Television.

It is necessary that certain basic properties should be understood if the practical application of this equipment to underwater work is to be fully appreciated. First and foremost, it must be realised that television is a means of vision, and is, therefore, like a diver, wholly dependent on light, contrast and water clarity for range of vision. This point cannot be stressed too much, and it must always be kept in mind when considering the application of television to underwater work. This statement needs further qualifying in that television will work at a lower light level than the human eye; in other words, it can give approximately 10-15 per cent. greater range of vision than a diver will obtain under similar conditions. There are certain areas where the opacity of the water renders television completely useless, but equally, there are large areas where it more than comes into its own. A disadvantage of television is that whereas in conditions of poor or no visibility a diver can augment what little vision he may have by a sense of touch; television lacks this. There is, however, under development a device known as the "Clear Water Container," which can be fitted in front of the camera to increase its range of vision artificially, under conditions of bad visibility.

Even in daytime, when the light level is adequate in the shallower depths, it is generally necessary to provide artificial lighting. This lighting plays an important part, not only by its intensity, but by its positioning relative to the camera, and the object being viewed. Generally speaking it should be as directional as possible, and in order to avoid back scatter, should illuminate only the minimum amount of water between the camera and the object being viewed. An instrument known as a hydrophotometer is available which will give readings of light penetration in water. Using this, the likely maximum range of television can be predicted for any given place.

When compared with a diver, television has the following advantages:

(a) It can be used in strengths of tide far in excess of that in which a diver can operate.

(b) It has practically unlimited underwater endurance. A diver's endurance underwater decreases with depth, such that in really deep work, down to say 300-ft., his underwater endurance is at the most 30 minutes. This also applies to an observation chamber, which, although capable of working at greater depths and in stronger tides than a suited diver, is still in fact limited in endurance.

(c) Divers and observation chamber operators are often working under conditions of severe discomfort, and mental strain, with a consequent loss of efficiency, whereas television can be operated and viewed in comfort and safety from the surface.

(d) Television can be used in depths down to 1,000-ft. at present, and is quite capable of development for use at even greater depths should the need ever arise. The maximum practical working depth for a diver is in the region of 200-ft., unless a highly trained diving team using a special ship and equipment is available, when it can be extended to approximately 350-ft. Any ship which can supply the requisite power, and is fitted with a derrick for handling the underwater camera, can operate television down to any depth, provided she is capable of being moored.

By filming or taking still photographs of the viewing screen, a permanent record is made available, either for subsequent inspection by persons not at the scene of the operations, or for record purposes Incidentally, the author has a theory, which has yet to be proved, that better underwater photographs will be obtained by photographing a television screen using the new techniques, than by direct underwater photography.

Several viewing screens in the ship can be operated from the main set, thereby enabling a large number of persons to view in detail any underwater operation. It is also possible for a ship to transmit over short distances to receivers ashore that which is being observed by its underwater camera.

Underwater Television—*continued*

Last, but not least, the main advantage of underwater television lies in the fact that the salvage officer or surveyor gets first-hand knowledge and is not dependent on second-hand reports from a diver, who may or may not have technical knowledge of the work he is surveying, and who at the same time is often working under conditions of mental and physical stress which may mar his judgment.

If necessary, a portable television camera can be used by a diver to augment his verbal reports, and enable the surveyor or salvage officer to obtain points of detail which might otherwise be missed by a diver lacking in technical knowledge.

The "Affray" Operations

General.

It will be remembered that in April, 1951, H.M. Submarine *Affray* was lost with all hands under very tragic circumstances. The submarine disappeared without trace in the English Channel whilst engaged on an exercise which allowed her a considerable latitude of movement. After the first two or three days, when all hope of saving life had been abandoned, the operation resolved itself into a methodical search of some 6,000 square miles. This involved accurately locating, plotting, and positively identifying each and all the numerous wrecks existing in the area. The enormity of this task can perhaps be better appreciated when it is realised that up to the time of the actual location of the *Affray* some 250 underwater contacts had been located and classified.

It was the task of H.M.S. *Reclaim* to follow up the searching force and identify by the use of divers and observation chamber all the contacts which showed promise of being the submarine, or could not otherwise be positively identified. Owing to the strong tides, depth of water (between 30 and 50 fathoms) and the exposed nature of the area, this was an extremely exacting and laborious task.

It was the realisation of these difficulties which led the Admiralty Research scientists to produce at such short notice the original equipment fitted in *Reclaim*. The author visited the Admiralty Research Laboratories at Teddington to ascertain whether or not equipment was capable of being fitted into and handled by the ship. The A.R.L. scientists had, in fact, produced a first-class workable piece of equipment which was immediately accepted.

The ship sailed within a day of its installation and the equipment was tested as soon as deep water was reached. It was a success from the start, clear pictures of the sea bed and fish being obtained during the very first submergence.

The search for *Affray* continued, but now *Reclaim* was able to identify contacts much more rapidly, since the television could be operated in stronger tides and under rougher weather conditions than a suited diver or observation chamber. Even so, suited divers and the observation chamber were still used when possible, in conjunction with the television.

At about noon on June 14th, *Reclaim* was investigating a contact located on the edge of the Hurd Deep, about 15 miles W.N.W. of the Casquets, in about 44 fathoms, operating an observation chamber over one side and the television camera over the other. The television camera, on reaching bottom, showed the white rails round the gun position on the fore end of the conning tower. By warping the ship, the camera was quickly manoeuvred to reveal the name *Affray* on the side of the conning tower.

The Original Equipment.

The original set produced by the Admiralty scientists for use in H.M.S. *Reclaim* in 1951 was a standard Marconi portable type of equipment as used by the B.B.C. for outside broadcast work. No electrical modifications were made to the actual television circuits themselves, but various devices were added which are not normally necessary for ordinary working. An ordinary English Electric commercial television set with a 15-in. screen was coupled up to the chain to enable more people to view. The power was obtained from the ship's normal 230-volt, 50-cycle A.C. mains, and the consumption was 2½ kw. The camera was attached to the derrick purchase wire by four short wire slings and was invariably operated with the camera looking downwards about 20° off the vertical. A standard 1,500-watt tungsten underwater diver's lamp, suitably shaded, was used to provide illumination. This was lashed to the camera frame, and its cable handled in a similar manner to the camera cable. The camera itself was about 12-in. x 12-in. x 18-in., and weighed 65 lb. This was housed in a welded steel cylinder, the walls of which were 3/16-in. thick, the flat ends being ½-in. plate. The overall dimensions of this cylinder were 17-in. diameter by 24-in. long. It was mounted on a light tubular framework made up from 1-in. gas piping, the object of which was to provide a base for the camera to rest on when inboard, and to provide protection from any undue physical shocks, both when being hoisted in or out, and when underwater.

Surveying the Wreck of H.M.S. Affray.

It must be remembered that at this stage only limited experience in the handling of the camera under water had been gained, and therefore the preliminary overall survey was carried out using an observation chamber, but as time went on television was used more and more, either in conjunction with a diver, or completely independently.

The preliminary survey had revealed the submarine lying on an even firm bottom with a list to port of about 15° and apparently undamaged, except for the snort mast which was lying over the port ballast tanks with its head resting on the sea bed.

Different divers in the observation chamber gave conflicting reports on certain detailed aspects of the submarine, such as the angle of hydroplanes, whether periscopes were up or down, and how much, etc., which tended to prove the fallibility of divers' reports given under conditions of stress. Using television, however, it was possible for a submarine expert in the ship to obtain accurate detailed first-hand information. Photographs of the television screen were also taken for the benefit of the Board of Inquiry, which was assembled ashore at Portsmouth.

Some of the uses to which the equipment was put are described in detail in the ensuing paragraphs.

(i) **Detailed Inspections.**—The television equipment was used to obtain close-up views of various parts of the submarine on which detailed information was required. To give the camera stability it was attached to a diver's shot rope by means of a sliding shackle, the camera and the shot being lowered and manipulated together, the ship being warped as necessary to position the camera over the desired part of the submarine.

(a) **Examination of Hatches.**—Close-up views of all hatches, including those for the indicator buoys were made to ensure that no obstruction had prevented their being used.

(b) **Inspection of Engine-Room Telegraphs.**—It was desired to ascertain what the bridge telegraphs were indicating. Close-up photographs were taken, which gave a clear indication of their position. Owing to the obstruction caused by the periscope standards, jumping wires, etc., it had not been possible to get this information by using the observation chamber.

(c) **Periscopes.**—Detailed and close-up photographs of the periscopes, standards, and associated equipment were taken.

(d) **Hydroplanes.**—An inspection of the after-end of the submarine from the observation chamber gave a good indication of the state of the after hydroplanes, but estimates of the angle of the forward hydroplanes, given by different observation chamber operators varied considerably. Close-up photographs were taken using television and these then compared with those of a similar submarine. By this method it was possible to ascertain the angle of the hydroplanes to within two or three degrees.

(ii) **Inspection and Recovery of the Snort Mast.**—A close-up inspection of the break in the snort revealed a crack on the outboard side of the fairing plate, and showed that the mast was only held by a very small piece of metal. This fact had not been noticed by the divers in the observation chamber. As it was only held by such a small piece of metal it was considered feasible to recover the mast. Here again the principle of the sliding shackle and the diver's shot was used. This enabled the shot to be placed immediately alongside the head of the mast, round which it was desired to put the recovery strop. The positioning of this shot was achieved in less than half an hour. Without television it would have proved a most protracted operation. It also had the

Underwater Television—continued

advantage that the suited diver who was detailed to place the strop could see what was needed, and have the operation described to him in detail before descending. Actually, through bad weather and strong tides, this shot had to be positioned no less than five times before it was possible for a diver to go down. After the strop had been placed, its positioning could be checked from the surface, and the second diver who was to attach the recovery wire to it was also able to see exactly what was required of him before leaving the surface. The television also ascertained that the path down the shot rope was clear of the overhanging obstructions from the periscope standards, etc., caused by the list of the submarine. The upper 28-ft. of the snort mast above the break was subsequently recovered intact, and undamaged.

Fig. 1 is a close-up of the actual break in the snort viewed from above. The portion at the right of the picture is still connected to the submarine and locked into the crutch, while the larger

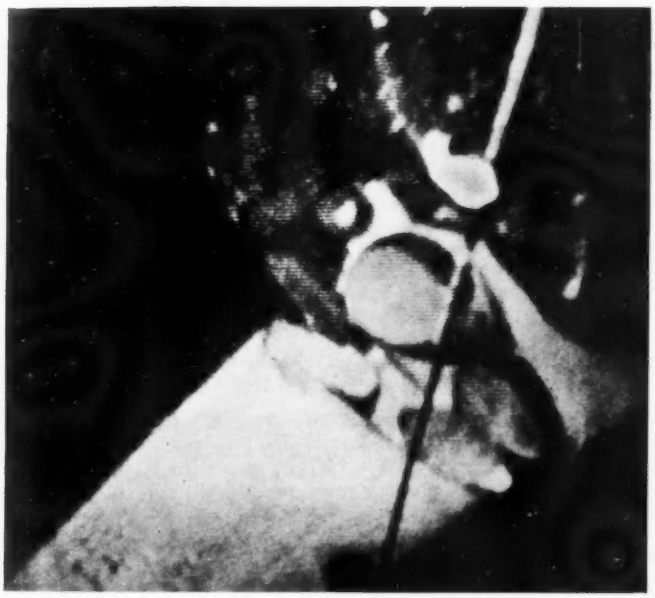


Fig. 1. The break in the Snort Mast viewed from above.

portion running towards the left and bottom of the picture is that which has broken off, and at the other end of which is the snort head lying on the sea bed. This picture proved that the snort mast was up and the locking-bolt in when disaster overtook the submarine, and that the break occurred just slightly above the crutch.

(iii) **Estimation of List.**—After the recovery of the snort mast, a period of bad weather ensued, and when operations were recommenced some weeks later, it was found that the list of the submarine had increased considerably. This led to the thought that the submarine was not entirely stable, and it was decided to try to obtain accurately the angle of list, so that it could be determined whether or not the submarine was gradually rolling over on her side. This was done by lowering the diver's shot until it just touched the periscope standard spreader bars, marking the rope inboard; warping the ship just clear, and lowering the shot until it touched the sea bed, marking the rope again; and then measuring the distance between the two marks. Using this information in conjunction with a scale drawing of that section of the submarine, and knowing that the sea bed was to all intents and purposes flat, it was possible to make an accurate estimation of the degree of list. Throughout this whole operation, television only was used.

(iv) **Attempts to Upright the Submarine.**—As it was desired to carry out certain work in the vicinity of the conning tower, on the port (lower) side, and not being certain that the submarine would not roll right over on to that side, it was decided that before divers should be allowed to work there, an attempt would be made to either upright the submarine, or roll her right over to starboard. A kedge anchor on a 4½-in. Extra Special Flexible Steel Wire Rope (E.S.F.S.W.R.) was hooked into position on the after periscope standard and spreader bar. This anchor also had a 3½-in. E.S.F.S.W.R. attached to it leading to another ship. At a given signal *Reclaim* applied a steady strain and the other vessel, after getting a steady strain on the wire, gradually increased speed on her engines. She was heading on a course at right angles to the fore and aft line of the submarine. The result of this operation was that the submarine did not shift, but the standards started to give, and the 3½-in. E.S.F.S.W.R. to the other ship parted. A subsequent estimation of the list of the submarine (as described above) showed that it was as before, and that therefore the submarine could be considered as having taken up a natural position on the sea bed and was stable. This whole operation was carried out entirely by television.

(v) **Removal of Casings.**—It was desired to inspect various fittings, such as the main snort induction line, certain buoyancy and ballast tank vents, etc., which lie under the upper deck casings between the after side of the conning tower and the engine-room hatch. This necessitated the complete removal of the free flooding upper deck casing in this area. For various reasons, underwater cutting and blasting could not be used, so it was decided to try and achieve this by using a kedge anchor. The kedge was slung by its gravity band in a nearly horizontal position with the object of hooking the flukes under the casing in the vicinity of the engine-room hatch to pull away the light metal from the frames. A good area of casing was removed by this method but it left a large number of jagged edges and bent and twisted frames which made it impossible for a diver to work in the very confined spaces with safety. It was decided that the only method of removing these would be by grab. An ordinary scissors grab which, at the author's instigation, had special one-foot jaws fitted, was manufactured at very short notice by Messrs. Westwood, of London, and obtained on loan from Messrs. Risdon Beazley, of Southampton. This grab solved the problem and the remainder of the area was sufficiently cleared, to enable divers to do their work.

(vi) **Photographic Records and Films.**—Still photographs of the monitor screen were obtained in the initial instances by an ordinary camera, hand held. For easy manipulation this camera was subsequently attached to a framework which could quickly be lowered into position in front of the screen to enable a picture to be obtained when required. A large number of photographs were

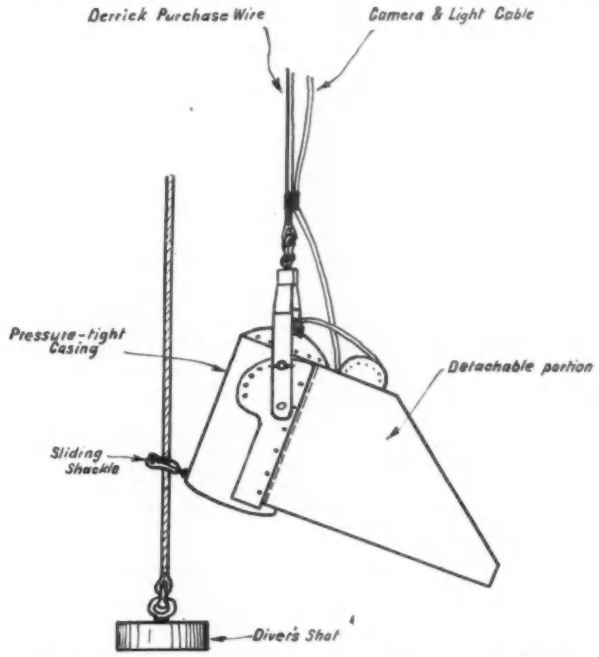


Fig. 2. Method of using camera for positioning diver's shot or operating a grab.

Underwater Television—*continued*

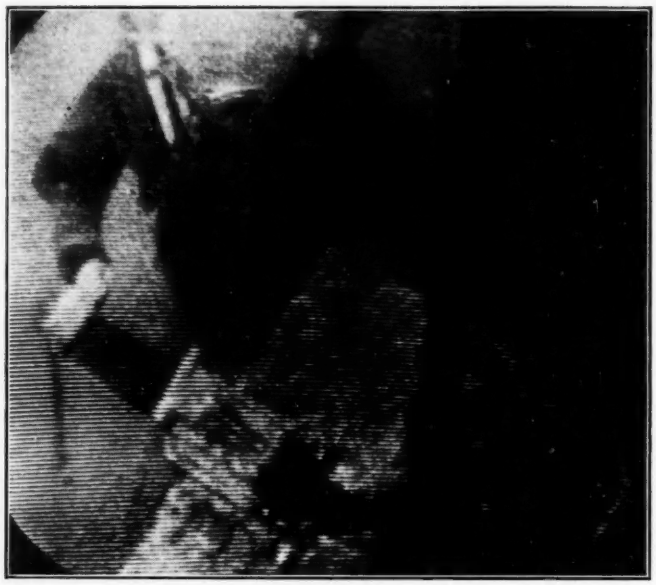


Fig. 3. Photograph showing how a diver can be observed at work under water and directed from the surface.

taken and the majority of these were submitted to the Board of Inquiry as irrefutable proof of the condition of the submarine. It must be remembered, however, that there is a very considerable loss of picture quality in these photographic reproductions of the monitor screen. In the later stages of the operation a short 16 mm. cine film was taken, which was surprisingly good considering the crude conditions under which it was taken.

Subsequent Operations by H.M.S. "Reclaim"

In May, 1952, the original equipment was removed from the ship, just a year after its installation, and a new set, which had been manufactured for the Admiralty by Messrs. Pye, of Cambridge, replaced it. This equipment embodied several new features and capitalised on the experience gained from the first year's working in so far as the design of the camera casing and handling arrangements were concerned. Once more a standard production equipment as supplied to the B.B.C. for use in their outside broadcast vans was used, and no major alterations were necessary to the actual television circuits themselves.

The camera casing which was built to the author's specification, is stream-lined for working in strong tides, and is also much more robust. It has been designed to allow the camera to operate down to depths of 1,000-ft. Its total weight is 17 cwt. and the light is housed at the after-end of the tail casing. The casing was purposely made to be heavy so that it would not tend to stream out too far when being operated at depth in a tideway. The cable and its handling arrangements are the same as that for the original set, except that there is 1,000-ft. of cable provided, thereby enabling the camera to be operated at much greater depths. Locking bolts, which engage on the quadrant from the pivoted slinging arms, enable the camera to be operated at any pre-set angle (Fig. 2). If these bolts are disengaged, the camera can be angled as desired either by a diver, or by manipulating a light wire from the surface, thereby allowing remote control in elevation. The scope of movement is from viewing vertically downwards to 15° above the horizontal. This light wire, which is attached to the shackle at the front of the camera, also serves to give very effective control in azimuth. The fixed sheave visible on top of the free flooding casing is the means whereby slack on the camera and light leads is taken up inside the casing when the camera is being operated by remote control in elevation.

Subsequent Experience with this Equipment

Reclaim's diving duties are many and varied, and during the year following the fitting of this equipment, every opportunity was taken of gaining additional experience in its use and application. This included carrying out bottom surveys, observing divers at work on set jobs, and also in conjunction with various other trials on which the ship was engaged. Basically, this work consolidated and extended the knowledge gained during the *Affray* operations in handling and controlling the camera under water. It also served to confirm that the design of the casing was on the right lines, and showed the immense possibilities of future applications. A typical example of this work is given in Fig. 3, which shows how a diver carrying out underwater work can be observed and directed from the surface.

During the *Affray* operations, the method used to move the camera about the wreck was to leave it suspended from the derrick purchase wire, and warp the ship as necessary to place it in the desired position. When, however, it is desired to carry out a survey of a wreck, dock wall, damage to a ship, etc., it is possible for the camera to be manoeuvred independent of the ship by using additional light wires attached to it, and handling it rather like a puppet. This method is illustrated in Fig. 4, and it is really amazing how finely the camera can be controlled even after only very limited practice. It is usually best to operate the camera at a fixed angle under these conditions. This method of camera control has the great advantage that it is easily capable of "on the spot" adaptation to meet any local requirements, the actual rigs being entirely up to the ingenuity of the officer in charge of the operation. The figure illustrates a rig for carrying out a survey of a totally submerged wreck lying on the bottom, or an area of the sea bed. With the camera horizontally viewing, a similar rig could also be used for surveying dock or harbour walls, lock gates, etc. Fig. 5 shows how the same principle can be applied to surveying the side and bottom of a ship. These are just a few of the methods of using this type of equipment, and it does not take a great deal of imagination to visualise any number of other ways in which it can be adapted for other uses.

Camera Casings and Handling Arrangements

As stated earlier in this paper, there is still room for a great deal of research into the various methods of handling and controlling the underwater camera. The author has had considerable experience of the type of equipment already described, but several other types of camera casings and handling arrangements have been evolved. One such equipment is shown in Fig. 6, produced by Messrs. Marconi-Siebe Gorman. It will be noticed that multiple medium powered lamps are employed, as opposed to the

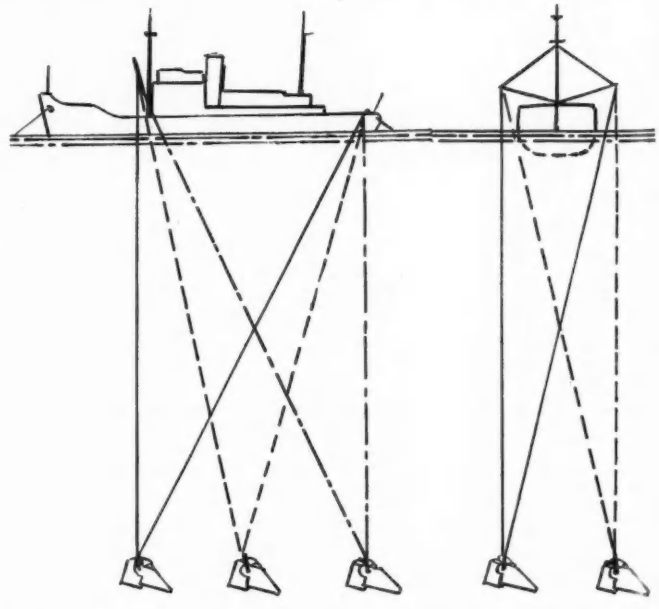


Fig. 4. Method of using camera for surveying a small area without moving the ship.

Underwater Television — continued

single high-powered lamp used in equipments previously described. These lamps can be used in combinations of pairs and are manually trainable.

This is undoubtedly a great advance, but the illumination problem remains until such time as directional remotely controlled trainable lighting is also incorporated to work in conjunction with it. It is considered that in anything but very clear water or where the natural light is sufficient to enable artificial light to be dispensed with, the back scatter from the water caused by having lights in close proximity to the lens is likely to have an adverse effect on the range of vision of the camera.

Another trend in development is for the camera casing to be gyro-stabilised, and controlled in elevation and azimuth, by remotely controlled follow-up motors, rather on the same lines that the existing B.B.C. cameras can be controlled remotely.

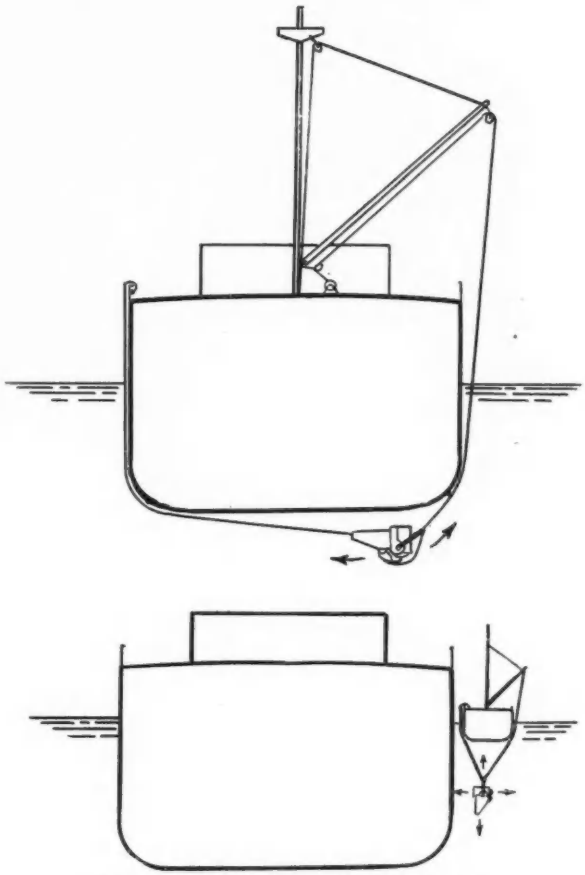


Fig. 5. Methods of surveying a ship's hull.

The author is of the opinion that although these various developments may well meet certain individual and specialised needs, they will be unnecessarily complex for general everyday use, and that the "puppet" method of camera control evolved by *Reclaim* will be found to be the most satisfactory. This method has the great advantage that it is simple, and easily capable of being adapted to meet any likely requirements on the spot. There is one development, however, which is worthy of note; that is, the small camera, which is shown in Fig. 7. This has been designed to take pressures up to an equivalent depth of about 300-ft. The total weight of the camera in air is about 70 lbs., and under water it has a positive buoyancy of 1 lb., thus it can be very easily handled by a diver or underwater swimmer. If it is desired to operate it without using divers, weights can be attached to make it negatively buoyant. Lighting can be either remote from the camera, or attached to it by means of a short arm which can be screwed on. Full remote-control of optical settings is also incorporated in this small camera.

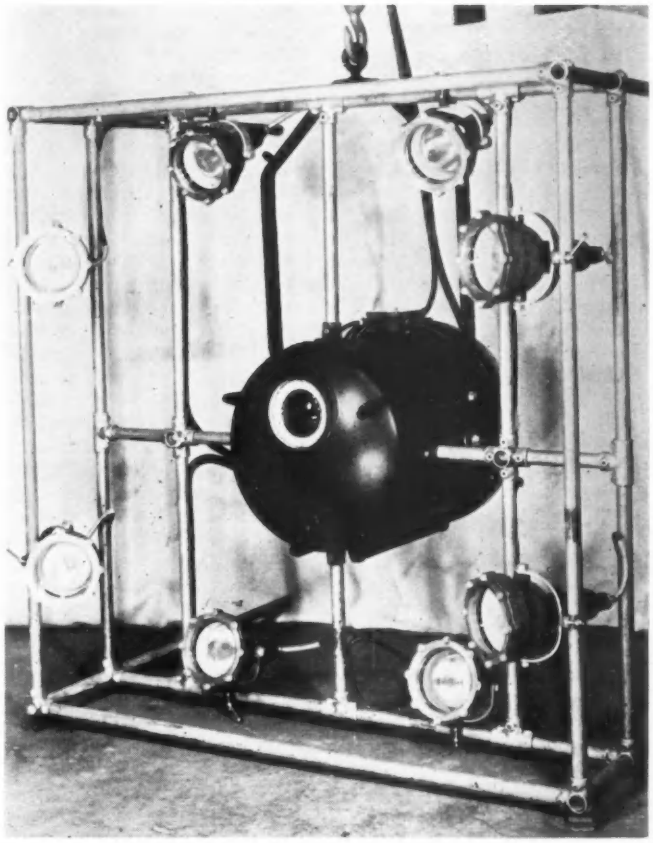


Fig. 6. Marconi-Siebe Gorman Mark I Camera.

The vast majority of work in connection with the surveying on underwater damage to ships, harbour installations, etc., and ship salvage (as opposed to cargo recovery) operations is not likely to take place in depths of water exceeding 200-ft., often much less, and therefore this lightweight camera lends itself readily to this type of work. The handling arrangements and basic camera design evolved by the author in H.M.S. *Reclaim* have proved themselves to be the best for all types of general purpose work.

The methods of remote camera control for carrying out surveys,

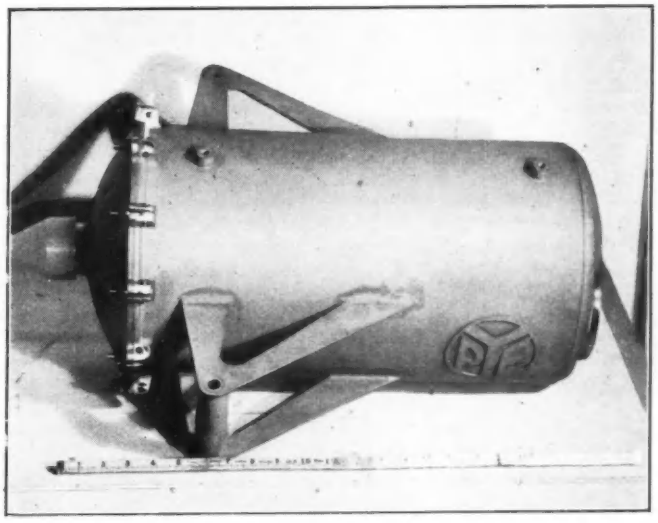


Fig. 7. Pye Portable Camera (note size against rule).

Underwater Television—continued

etc., illustrated in Figs. 2, 4 and 5 could be employed, and further, with the free flooding casing detached, the camera could be used manually by a diver either to augment his verbal reports or enable a surveyor or salvage officer to obtain points of detail from the diver whilst actually carrying out his work. If such a camera were attached to the diver by a short, stray line, then, because it has a slight positive buoyancy it would, when released, float just above him and remain within easy reach. Thus the diver could have both hands free to do any particular piece of work, on completion of which he could direct the camera on to it, and satisfy the salvage officer that it was done to his satisfaction, or ask him for further directions.

Envisaged Applications

Under certain conditions, television should enable a great saving in time and money to be made over the dry-docking of ships. Take for instance the case of a ship that has sustained underwater damage and is in need of dry-docking to effect repairs. A television survey of the damage can be made, repairs decided on, and, if necessary, new sections prefabricated before the ship ever need enter the dock. Take also the case of a ship which has sustained damage, when there are no docking facilities available; television should enable the surveyor to decide what temporary repairs are necessary, and whether or not to issue a certificate of seaworthiness. In some of the more remote places this should prove invaluable, especially when it is borne in mind that the small lightweight camera and its associated equipment, including a portable generator, is capable of being flown to the area in a small aircraft.

Except perhaps for very large salvage firms or corporations such as Lloyds, it may well be that the very high initial cost will prevent television becoming an economic proposition, especially if it is only likely to be required for use over short periods at a time. This, coupled with the rapid developments that are taking place, and the need for the employment of special operators, leads the author to the conclusion that the only really practical and econmical way in which television can be fully exploited is for the firms who manufacture the equipment to have a number of sets and operators available for hire, as and when required. This system is already employed by certain firms in connection with various types of radio and navigational aids.

Thus if a docks or harbour board required the use of equipment for a period of two or three months to carry out a particular survey, a set plus operators would be hired just for that period. This would ensure that the equipment was the most up-to-date available, and that the operators would be men fully conversant and experienced in its use. It is understood that certain firms are considering the idea, and have already got equipment which is available for hire. The efficient operation of such equipment requires a good technician, to set up and operate the electronics of the set, plus a good seaman, with a knowledge of the factors such as illumination, etc., which affect its underwater efficiency, to handle the underwater camera. It cannot be stressed too strongly that the efficient remote controlling of the underwater camera is basically common sense and good seamanship, coupled with a little ingenuity.

Summary

To date, the equipment has been successfully applied to the following:—

(a) The location and identification of underwater objects.
(b) The positioning of divers' shot ropes.
(c) The " briefing " of divers before going down.
(d) The observation and direction of divers engaged in underwater work.
(e) The operation and control of mechanical and electromagnetic grabs and grapnels when under water.
(f) The survey of underwater damage, etc.
(g) The recording of underwater operations by means of still or cine photography.
(h) The transmission of underwater pictures to other receivers remote from the ship operating the equipment.

It is perhaps well to end on a warning note; in spite of its immense possibilities, the fact that television is dependent for its efficiency on water clarity, lighting, etc., must not be lost sight of. Television will be little or no use in some areas where the water is very dirty, until such time as the clear water container now under development is available. A hydrophotometer survey can, however, quickly ascertain the efficiency to be expected from television in any particular area.

Canadian Harbours

Annual Report for 1953

The eighteenth annual report of the National Harbours Board, covering the operations of the harbours of Halifax, Saint John, Chicoutimi, Quebec, Three Rivers, Montreal, Churchill and Vancouver and the Government grain elevators at Prescott and Port Colborne, states that while the aggregate cargo tonnage in 1953 was slightly in excess of that for the previous year and established a new record, the unfavourable feature of the cargo movement was a decline of 9 per cent. in foreign outward traffic.

The financial results were the best in the experience of the Board with operating revenues of over $21,000,000, and a net income surplus of $2,400,000.

An extensive construction programme of new and improved harbour facilities was carried on during the year. Major projects completed or in progress represented a total outlay of $14,000,000.

The Vancouver harbour terminal railway was transferred to the Canadian National Railway Company as of January 1, 1953.

Vessel arrivals in 1953 numbered 49,961, the aggregate net registered tonnage being 45,307,299. The comparable figures for 1952 were 47,821 vessels, aggregating 42,652,542 net registered tons.

The aggregate cargo tonnage in 1953 was 42,525,237, as compared with 42,337,198 in 1952, the increase being 188,039 tons.

Grain traffic was again at a high level, the total tonnage figure being only slightly below that of the previous year.

Foreign inward traffic increased 450,889 tons, or 5 per cent., and foreign outward traffic decreased 1,358,195 tons, or 9 per cent., compared with 1952. Domestic traffic inward increased 1,376,914 tons, or 12 per cent., and domestic traffic outward decreased 281,569 tons, or 4 per cent., compared with 1952.

Operating revenues of all units in 1953 amounted to $21,032,018, as compared with $20,298,693 in the previous year. The increase was $733,325, or 3 per cent. If the figures are adjusted for comparative purposes to allow for the loss of Vancouver harbour terminal railway earnings in 1953, an effective increase in revenues of $1,211,565, or 6 per cent., is shown.

I.C.H.C.A. Meeting at Naples

One of the largest conferences organised by the International Cargo Handling Co-ordination Association since its inception two years ago was held in Naples from 31st May to 4th June last. The meetings were held in the Conference Hall of the International Marine Exhibition which was opened during the previous week and details of which were given in the December, 1953, issue of this Journal.

On the first day of the conference the delegates were welcomed by Dr. Luigi Accame, president of the Italian National Committee of I.C.H.C.A. and by the Mayor of Naples, representatives from the Italian Ministry of Marine and others. Several speakers commented favourably upon the progress made by the Association over the past two years; short addresses were also given by the delegates who referred to the fact that they were attending with the object of learning new ideas and methods in the technique of cargo handling.

During the following three days, technical meetings were held, when a symposium was presented to consider the requirements of the ideal port, its layout, construction, equipment and operation, and how those who use it can contribute to its efficiency in the balanced growth of international trade.

As the papers which were read and discussed during the meetings are likely to be of interest and value to many readers of this Journal, it is proposed to publish extensive abstracts from a number of them in the July issue.

Dolphins at the Port of Amsterdam

Installation of Flexible and Rigid Types

By ir. T. J. RISSELADA
(Chief Engineer of Public Works Department, Chief of the Harbour Works Division)

WHERE big modern oil tankers, with their enormous cost, are concerned, any saving on the construction of the berthing structures, if it is done at the expense of quality and efficacy, must be regarded as a false economy. The extra expenditure on the accommodation will be more than offset by the operating time gained and the quicker and better service proffered.

Although dynamic loads have practically no influence on the construction of quaywalls, they play an important role in the design and calculation of dolphins and jetties. In accordance with the law of the conservation of energy, the energy to be absorbed by the berthing structure is usually considered to be equivalent to the kinetic energy of the vessel.

In order to compensate for neglecting other causes of energy absorption, some correction factor can be introduced. This factor, whose value is largely based on experience and careful assessment, is assumed to vary between 0.95 and 0.80 according to *inter alia* the rigidity and mass of the dolphin or jetty[1].

Other assumptions are needed for the computations underlying an adequate and economic design, e.g. direction and type of impact, velocity and method of berthing, special allowances and margins. These all should be the subject of a careful scrutiny, as they can vary widely according to specific conditions. Furthermore, due attention should be paid to subsoil conditions and such practical matters as maintenance and repair.

In the following pages, two types of dolphins recently designed and built in the Port of Amsterdam will be described and briefly discussed.

The first group, constructed on behalf of an oil company, can accommodate tankers of up to 60,000 tons displacement, berthing at a speed of ½-ft. per second. The second group—situated in front of a granary—can accommodate vessels of up to 22,500 tons displacement, berthing at a speed of 8-in. per second.

DOLPHINS FOR AN OIL COMPANY

I.—General Layout.

In connection with an extension of tank storage of the oil storage firm "Amatex" in Amsterdam, one of the berths had to accommodate both very large tankers of 60,000 tons displacement and 40-ft. draught, and coasters and inland craft of 2,000 tons displacement and less.

In these circumstances a T-shaped landing stage seemed best fitted for the purpose. Of such a landing stage the most economical design is achieved when the safe berthing of the ships is assured by some dolphins and the connection with the shore is accomplished by a simple jetty. Taking into account the desire of the concern to utilise an available pontoon for this landing-stage, the construction of a sort of jetty-bulkhead 30-ft. long to which this pontoon could be secured, would suffice. This simple solution is possible because Amsterdam is not a tidal harbour and consequently the fluctuations of the water level are insignificant. For berthing the large, medium and small tankers, a group of two large and two small dolphins have been designed, spaced at distances of 230-ft. and 66-ft. respectively. Moreover, a number of mooring bollards have been placed on shore (Fig. 1).

Since it is regular practice in the Port of Amsterdam to employ special crews equipped with launches for the securing of the ropes and hawsers, it seemed sufficient to fit the dolphins with ladders without connecting them to the jetty.

II.—Determination of the Type of Dolphin.

In designing a mooring accommodation ensuring a perfectly safe and "soft" berth for the tankers in all circumstances, the choice lies between a dolphin of the flexible type without special fender equipment, or a dolphin of the rigid type with special energy absorbing fenders. These fenders, however, are all more or less complicated devices, making special securing and housing provisions to the dolphins inevitable and requiring permanently a thorough maintenance.

In the design under consideration, having economy in mind, any practical deflection could be accepted, provided the thrust (reaction) did not damage the hull of the berthing vessel. Therefore assuming the impact to be 100 tons maximum the horizontal length of contact between ship and dolphin should be at least 8-ft.

To obtain a flexible structure it is necessary to make use of slender elements as these can take a high degree of bending. This leads logically to a structure supported by a number of piles of some sort. As the dolphins are subject to repeated action from the same direction, careful attention had to be paid to their behaviour over a period of time, especially as at this site consolidated strata with good bearing capacity are lacking. Thus the design must preclude any significant vertical forces on the piles and the ground.

In order to avoid any differential settlement of the piles, it is imperative to apply hinged braces to connect the heads of the piles instead of fixed connections which turn the structure into a rigid framework. Hinged braces prevent the piles from transmitting tensile and compression forces of considerable magnitude into the subsoil[2].

Though hinged connections are a little more complicated than rigid ones, this minor complication is well compensated for by the greater resilience which reduces the value of the impact—and the reaction on the hull of the vessel—by half.

The directions of impact on dolphins (particularly in the case of large dolphins or those rectangular in plan)[3] are generally such that there is a large variation between the loads exerted on different piles, amounting in some cases to more than 50 per cent., with a consequent reduction in the efficacy of such structures. To overcome this deficiency the structure can be made rigid against torsion by applying a special device by which the momentum of the whole caused by an eccentric blow will be conveyed into one or more piles able to resist a certain amount of torque. The shear stresses thus arising in the piles may be very small if a favourable (e.g. circular) section is applied.

In considering the material of the piles, where the energy must be absorbed in bending, the reinforced concrete is not suitable at least until thorough experience is available with pre- or post-tensioning of piles of some size.

As regards hardwood, it can be stated that for a similar dolphin (assuming a bending stress of 10,300 lbs./sq. in.) about twenty 16-in. x 16-in. azobe piles 100-ft. long would be required, the cost of which is not less than that of the steel tubes purchased for the chosen type of dolphins. In order to obtain a correct comparison one should moreover calculate the extra cost of pile driving and more complicated bracing, not to mention the difficulty and delay in obtaining these excessively long hardwood piles (at least a year as compared with two months for the steel piles used). It is interesting to note that while for small dolphins the cost of steel is mostly higher than that of hardwood piles, for bigger dolphins steel becomes more economical.

Sheet steel piling driven in a number of short rows, one behind the other, though leading to a design attractive from an economic point of view was not used because it is flexible only to blows in the normal direction. In case of glancing blows it does not provide satisfactory resilience and requires special measures to resist torsion, while the shear forces in the interlocks are difficult to deal with.

The amount of steel and the cost per unit of work are known to be lowest for normal high tensile steel. A comparison was made

Dolphins at the Port of Amsterdam—continued

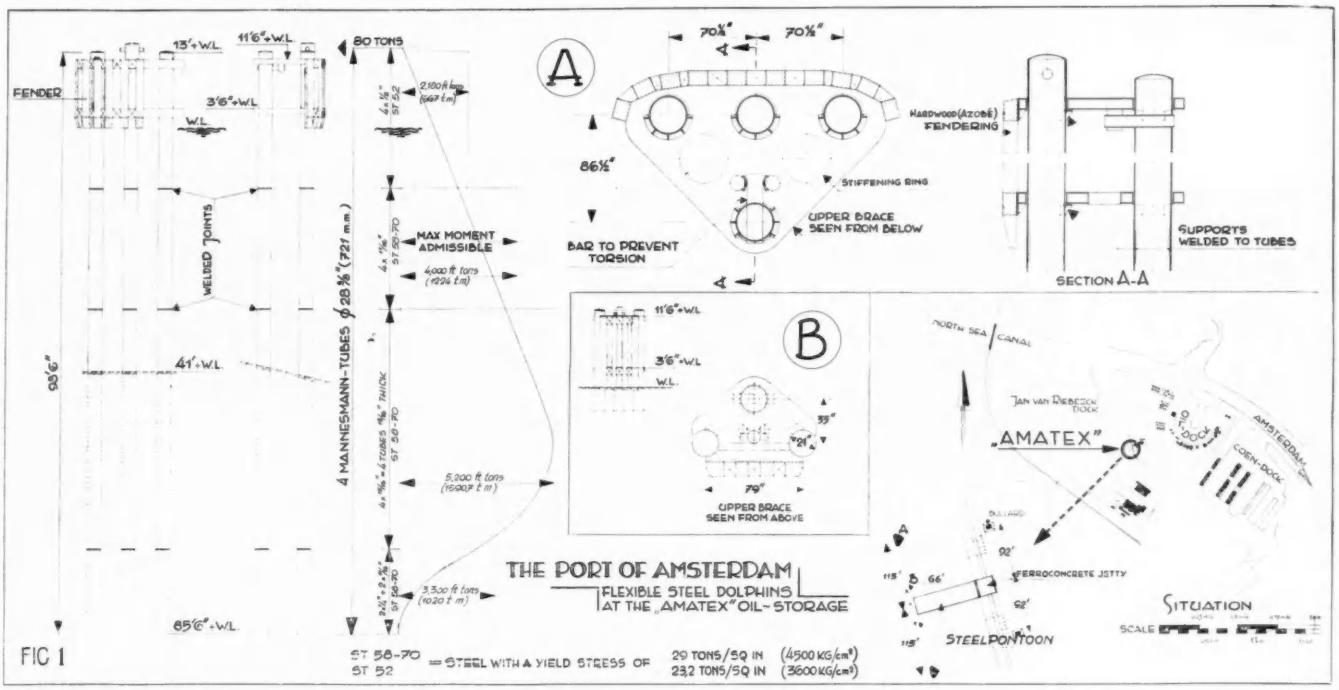


FIG 1

of tubes made of three types of steel: St. 37, St. 52 and St. 58/70 (yield stresses being 14.1, 23.2, and 29 tons per sq. in.). Taking into consideration the dynamic *and* static requirements and taking the unit cost of St. 58/70 as 100, St. 52 is 120 and St. 37 is 150. The application of tubes of St. 75/90 (yield point 36.3 tons/sq. in.) was not considered since they were not available at that time.

A further comparison was made between:

(a) tubes of steel St. 58/70 of 28-in. diameter, and various sections of steel St. 52, viz.:
(b) 27½-in. x 27½-in. hexagonal piles made by welding together six "U" shaped elements.
(c) 19½-in. x 19½-in. square piles made by welding together four "U" shaped elements.
(d) 18-in. x 20-in. hexagonal piles made by welding together three elements bent along the longitudinal axis through 120°.

A column or pile of circular or annular cross-section has the same amount of inertia about all horizontal axis through the centre. This is advantageous when the loads may be applied from all directions, although it is less economical in material distribution than other sections when the direction of load application is more specific. The latter factor is recompensed by the fact that, according to research by Siebel[4] for circular sections of steel St. 52 the yield stress in bending is 1.3 times the yield stress in tension*.

With regard to cross-sections composed of several U-shaped elements welded together along their entire length, there are indications that in order to obtain a reliable structure a maximum stress lower than the yield stress should be used[5]. This reduction is greater for a cross-section composed of six elements than for one composed of four, and in addition there are objections against the former cross-section, probably in connection with the reliability of the welds. Therefore, nobody has yet ventured to make use of this hexagonal type for such structures that are specially subjected to bending. Reckoning with a reduction of the stresses of 20 per cent. and 10 per cent. respectively, the cost-prices and the required number of piles based on the modified maximum stresses have been inserted in parentheses in the following table.

Although in the first instance the—six elements—hexagonal cross-section seems to be the most attractive, taking the reduction in maximum permissible stress at 20 per cent. for hexagonal and 10 per cent. for square sections, a circular cross-section is preferable, even if it was only because of the unit cost of the piles.

Moreover, taking into account that the additional costs of driving, bracing constructions, etc., owing to the smaller number of piles are also lower and that a circular section offers more resistance to torsion, it needs no further comment that the application of tubular piles of high tensile steel was decided on.

The following is a comparison of the various sections considered. The figures in parentheses show the amended numbers and costs, taking into account the amended maximum permissible stresses as discussed above.

Section.	Number.	Purchase Cost
(a)	100 (75)	100 (75)
(b)	225 (275)	70 (85)
(c)	475 (525)	125 (140)
(d)	325	100

As can be seen from Fig. 1, by using various qualities of steel and thicknesses of tube wall, the radius of gyration can, to some extent, be varied to suit the bending moment.

III.—Design of the Dolphins.

Since in Holland heavy, 98-ft. long, tubular piles had never yet been driven it was considered undesirable to run any risks with regard to driving, the more so as pre-flushing by means of water-jets could not be allowed.

Taking the size and weight of the monkey of the available pile-driver into account, it was determined that the maximum diameter of the tubes should be about 2-ft. 3-in. (70 cm.). The consequence was a design consisting of four tubes with a diameter of 2-ft. 4-in. (721 mm.) for the large dolphins, and of three tubes of 1-ft. 9-in. (521 mm.) for the small dolphins. Another device has been considered, consisting of a few piles of a smaller diameter in front and a pile of a larger diameter at the back[6]. By giving the thinner piles more play in the holes of the braces while taking account of the difference between the deflections of the heavier and the lighter piles under ultimate load a greater resilience of the dolphins under smaller impacts is achieved. In this way a more agreeable berthing is given for smaller craft than in the case of all piles having the same diameter. But because of the limitation of the diameter such a design had to be dropped for reasons of economy.

The pile arrangement chosen resulted from a careful study of the

* Since in bending the yield stress is reached first in the outmost fibre, it will be clear that in the case where a circular section is used, plastic deformation will not occur before the stress, and thus the load applied has been actually increased.

Dolphins at the Port of Amsterdam—*continued*

dimensions and curvature of the wooden front of the dolphin, a favourable end fixation of the cluster of piles in the subsoil and the limitation of the torsion in case of eccentric blows.

To obtain a good distribution of the dynamic and static forces over all the piles, hollow diaphragm braces are provided consisting of steel plates and resting loosely upon brackets (consoles) welded to the tubes. The loose fit answers effective hinged connections between braces and tubes, as is illustrated by the detail given in Fig. 1 (upper right). To prevent vessels striking the dolphins below the lower bracing, the timber fendering protrudes 1-ft. 8-in. and extends below the water line. This could have been effected by placing the lower bracing below water level, an idea which was not adopted for obvious practical reasons.

IV.—Calculations.

The leading dimensions are shown in Fig. 1. Though the energy to be absorbed by the structure can vary in normal cases from 0.25 to 0.75 times the total kinetic energy[7], by introducing the reduction factors as already stated, the assumption of half the total kinetic energy in this case seemed justified. Because the berth is rather exposed to prevailing westerly winds, the assumed berthing velocities are higher than normal for the calm, tideless waters of the port.

The basic design data are:—

	Large Dolphins	Small Dolphins
Maximum displacement	60,000 tons.	3,300 tons.
Maximum berthing speed	½-ft. per sec.	1 ft./sec.
Kinetic energy (impact at W.L. + 3′ 3″)	1,400 in. tons.	300 in. tons.
Static load (rope pull on bollard)	80 tons.	20 tons.
Ditto (wind pressure at W.L. + 1′ 8″)	100 tons.	15 tons.

To determine the driving depths and the bending moments of the piles it is necessary to know something of the subsoil. To that end some deep soundings with a cone penetrometer[8] and borings were made and some undisturbed samples taken. From triaxial compression (cel) tests, it was learned that an internal angle of friction of 20° as an average would be fairly representative for this subsoil built up from strata consisting of fine sand, clay and a little peat in various mixtures. The specific weight of the subsoil was found to be 1.8 tons per cubic metre, and 1.0 tons per cubic metre respectively above and under water. Considering the texture of the soil, its very fine pores giving it a low grade of permeability, it seemed justified to substitute the 1.8 instead of the 1.0 value in the formulae in case dynamic loads (short duration) are involved.

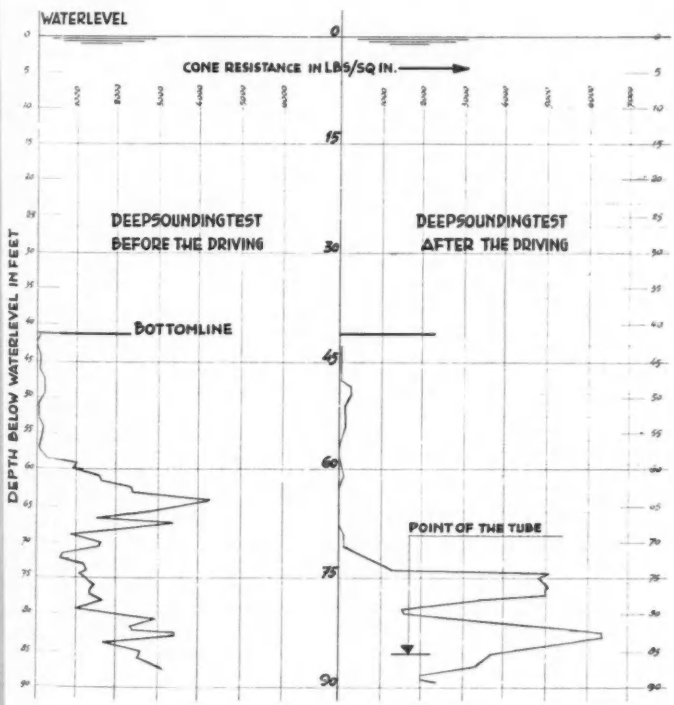


Fig. 2.

Front view of two dolphins of the rigid type. Note rubber fendering.

Departing from the basic formula $P = \frac{M}{h + X_m}$ — where h = distance between load and bottom—the max. load is found by substituting the value X_m, indicating the location of the max. bending moment below the bottom. This X_m can be derived according to one or other method, taking into account the soil pressures present *in situ*. To this purpose Blum[9] has developed a formula which was chosen because it has led to good results elsewhere and it is simple in use.

Finally, the driving depth and the deflections can be calculated.

Another formula developed by Brennecke Lohmeyer[10] has also led to good results but gives slightly smaller values for X_m and the required driving depths.

Since the static loads proved to be more critical than the work absorption, the Blum formula was preferred, as with this greater values for depth of the max. moments are found*. Introduced into further calculations it ensures that the dimensions of the structure remain on the safe side. Since it is a matter of discussion what part of the soil adjacent to the piles will co-operate in the fixation of the piles, the form of it and therefore the width of it to be substituted in the calculations are discussible. It seemed that as an average the total width of the front pile rows would be a fair assumption, i.e. 14-ft. 1-in. and 8-ft. 4-in. respectively for the big and for the small dolphins.

Three cases were investigated:

(1) a static load from various directions on the bollard owing to rope(s) pull.
(2) a static load on the timber fendering near the water surface owing to wind forces.
(3) a dynamic load from various directions at the level of the lower brace due to the impact of berthing vessels.

The designs adopted were four piles with a diameter of 2-ft. 4-in. and wall thicknesses of 15/16-in., 11/16-in. and ½-in. for the big dolphins and of three piles with a diameter of 1-ft. 9-in., and wall thicknesses of 9/16-in. and ½-in. for the smaller dolphins.

The value of X_m is 15-ft. and 10-ft. respectively, requiring a driving depth into the soil of 44-ft. 6-in. and 31-ft.

The deflections under worst loading conditions amount to 2-ft. 4-in. and 3-ft. respectively when the impact is at the level

*It should be pointed out that actually neither formula is supposed to be quite correct in case of dynamic loads. As according to some experiments the value of X proved somewhat smaller, one should take into account that the results of their application give a too favourable picture of the work obsorption of the structure.
This phenomenon has now the special attention of Prof. Geuze of the Laboratory of Soil Mechanics of Delft

Dolphins at the Port of Amsterdam—continued.

of the lower brace and to 3-ft. 8-in. and 4-ft. 3-in. respectively when the impact is at the level of the top brace.

To verify the soil mechanics assumptions and the validity of the formulae used, some bending tests were carried out afterwards on single piles as well as one of the small dolphins. The results showed a very satisfactory accordance with the calculated deflections.

It is worthy of note that although immediately after these tests the dolphin (piles) did not fully return to their original position—one can speak of some sort of hysteresis—it was ascertained that after some hours the piles had completely recovered from their set.

Moreover, some comparative deep sounding tests with a cone penetrometer were carried out before and after the driving—the latter made inside the pile—in order to observe the effect of the driving on the density of the various strata inside and under the pile (Fig. 2). It was confirmed that a hollow pile acts more or less like a closed one due to the clogging of the material compressed inside the pile. The compression below the point of the hollow pile, however, has contrary to the preliminary expectations been found to be confined to a rather limited area and was less than would have been the case for a solid one.

That this area is much less than in the case of a solid pile can presumably be ascribed to the fact that the strata passed consists mainly of material of low resistance and density.

V.—Execution.

The driving took place with a normal Menck and Hambrock floating rig. A single acting steam hammer with a weight of 4.5 tons and a drop of 2 to 3-ft. was used. The driving met with no difficulties whatsoever, in spite of the fact that the crew had no experience in the driving of tubes, some of which had a length of about 100-ft., whereas the max. height of the rig under the monkey amounted to only 58-ft. The lowering and adjusting of the piles right into their correct positions was the most difficult part of the whole procedure. The actual driving over a length of some 40-ft. took less than one hour. It proved possible to place a pile of the smaller type in half a day, whereas for the bigger type nearly three quarters of a day was required.

The supports were welded to the tubes, and the lowering of the braces on to them was a simple job. Since the floating pile-driving rig was still available no special sheerlegs was required for the adjusting. The bolting of the timber fendering onto the braces completed the operation.

The time from placing orders for the piles to completion of the dolphins, was thus a few months. To record the procedure a film was made which clearly shows its simplicity and ease of construction.

(to be continued)

National Dock Labour Board

Annual Report for 1953

The report and accounts of the National Dock Labour Board for the year ended January 2, 1954, were published early this month.

Dealing with the relationship between the volume of trade and the level of dock employment during 1951, 1952 and 1953, the report shows that the easing of restrictions on imports at home and elsewhere has been reflected in a slight but steady rise in trade, and that the volume of dock work has increased correspondingly. It is interesting to note that the position reached by the end of the year under review very roughly corresponded to that which obtained during 1950, both in respect of the level of employment and of the Register of workers available to participate in it.

Labour Force

During the early weeks of the year under review, surplus labour continued at the same high level as had been experienced in the last quarter of the previous year. It became evident that the conditions of the Temporary Release Scheme introduced in the previous December were not attracting sufficient applicants to have any material effect; the number of men who had left under this scheme at the beginning of the year was no more than 170. In January, therefore, the Board modified the conditions to permit men to be temporarily released for a period of not less than three months, subject to the same conditions as to reinstatement as had previously been announced. This relaxation commended the scheme to a greater number of men and releases increased steadily until, in April, they reached a total of 1,186.

Concurrently with this, the Board had continued the ban on fresh recruitment to the Main Register, and by these two means the available force was gradually brought more into line with day to day requirements which were beginning to climb from the low level to which they had dropped in the third and fourth quarters of 1952. By early summer, therefore, the National Board felt able to restate its labour policy in more positive terms than had been possible during the slump in employment which had just been experienced. Local Boards were accordingly informed of the steps which it was considered could most expediently deal with the requirements for additional labour which were expected in a number of port areas, and they were authorised to act on the following lines:—

(a) To regulate the operation of the Temporary Release Scheme and to invite men released under that scheme to return as local requirements appeared to necessitate.

(b) To examine the cases of men who had voluntarily left the Industry following the Standstill Order but prior to the introduction of the Temporary Release Scheme, and who wished to return to the Industry.

(c) To review individual cases of men who had been dismissed from the Industry and, where this was justified by the circumstances, to re-admit them to the Register at the expiry of not less than four months from the date of dismissal.

(d) Wherever it was evident that additional short-term requirements were directly related to purely seasonal increases, to endeavour to meet these by the use of non-registered labour.

Where these measures did not suffice to meet labour requirements and where satisfactory evidence could be produced, the National Board was prepared to authorise the creation of Temporary Registers to supplement the established labour force. Where recruitment on a temporary basis was operative, the National Board announced that automatic authority would also be given to Local Boards to recruit to the Main Register to replace current wastage.

In the circumstances prevailing early in the year, the Board's primary concern was to effect a reduction in the actual, as distinct from the sanctioned, strength of local Registers. In order, however, to replace the matter on a more realistic basis, it was decided in February to adjust the sanctioned strength, then standing at over 81,000, to bring it into line with the number on the Main Register at that time and the total was accordingly reduced to 76,220. In the light of further experience of the development of trade and of future prospects in the individual port areas, the Board carried out a subsequent review of sanctioned strength towards the end of the year, as a result of which the total was adjusted to 74,440 so far as the Main Registers were concerned, while Temporary Registers totalling 845 were authorised in addition.

The number of weekly workers included in the Main Register increased slightly during the year from 14,274 to 14,453, thus continuing the tendency noted in recent years.

The analysis of the outflow shows that 1,510 men on the Main Register and 153 weekly workers on limited registration left the industry of their own accord during the year. These figures compare with 3,737 and 170 in 1952 and undoubtedly reflect the improvement in working prospects. The high rate of turnover of labour, which has for many years been a disquieting feature, has, therefore, been somewhat retarded during the past year, though the Board recognises that much still remains to be done before it can be claimed that a thoroughly efficient and balanced labour force has been established.

Training of Workers.

In view of the limited extent of fresh recruitment to the Main Register the need for formal training was very restricted and the

National Dock Labour Board—continued

total cost of training schemes accordingly dropped from £2,537 in 1952 to £1,457 in 1953. The Board has watched with interest schemes for training dock workers in other countries, particularly that recently introduced in Rotterdam. The Board proposes to seek first hand information as to the manner in which this scheme is working out in practice, so as to be fully informed as to the best means of providing technical training in this country.

The daily average in employment rose very slightly from 56,832 in 1952 to 56,888, though it will be appreciated that the figure for 1953 has been damped down by the relatively poor level of employment during the first quarter.

The employment of non-registered labour, which had fallen away in 1952, again reached a significant level, particularly in the second and third quarters of the year. The extent to which non-registered labour can be engaged is dependent upon the general level of employment in the area concerned, and transfers on a daily basis depend not only on the number of other ports within travelling distance, but also upon their current employment position. It will be appreciated that recourse to period transfers, which are on a voluntary basis, is limited in practice to those relatively rare cases in which it is possible to forecast in advance a sufficient period of steady employment for the men involved.

Absences on account of sickness and injury show little significant change from the previous year and it is gratifying to note that further reductions have been recorded in the already low figures relating to those not accounted for or excused attendance. The number of man/days lost through labour disputes totalled 32,015 which, although greater than the exceptionally low figure recorded for 1952, was only a fraction of that experienced in earlier post-war years.

The cost of operating the Scheme during the year was £4,410,227 compared with £5,296,038 for 1952. The total operating costs during 1953 were equivalent to a levy of 15.8 per cent. of the gross wages of daily workers, as compared with 19.2 per cent. in the previous year. Expenditure arising entirely from Industrial Agreements and statutory obligations which would fall on the dock employers irrespective of the Dock Labour Scheme, amounted to 8.5 per cent. of the wages of daily workers, compared with 8.7 per cent. in 1952. On account of the relatively improved employment, payments made under the Scheme at rates fixed by Industrial Agreements represented 4.4 per cent. of the wages of daily workers, compared with 7.4 per cent. in 1952. Expenditure on capital items in 1953 accounted far substantially the same proportion of the total expenditure as in 1952, and was, in fact, to some extent reduced by a credit arising through an appreciation in the market values of investments.

Earnings of Daily Workers

The average gross earnings of daily workers have improved during the year corresponding to the improvement of the level of employment, which is also reflected in the decrease of payments of attendance money and guarantee make-up. The average earnings for the second and third quarters are, as usual, affected by holiday pay, while the figures for the fourth quarter reflect the increased rates of pay. Notwithstanding this, total gross earnings were approximately the same although, as a result of the Board's labour policy, the number of men on the pay roll had been reduced by nearly 5,000. The average weekly gross earnings of daily workers last year was £10 5s. 4d., the average pay roll totalling 56,833. Comparative figures for 1952 were £9 9s. 6d., and 61,653, respectively. Total gross earnings last year were £30,342,714, as compared with £30,957,495 in the previous year.

Building Programme

During the year there has been considerable progress in the Board's building programme of call stands, offices and medical centres. This cannot be measured entirely in terms of capital expenditure (which, in fact, dropped slightly from £209,459 in 1952 to £192,083), since a number of important buildings came into use during the late summer and autumn and the final accounts had not in all cases been cleared by the end of the year. Call stands were completed and brought into use at Hull (Albert Dock), Liverpool, Garston, Manchester (Salford Docks), Preston, and Glasgow (Shieldhall, Princes Dock and Queens Dock). The premises at Queens Dock, Glasgow, include area offices for the Board's staff and new area office accommodation had also been brought into use during the year in London, Liverpool and Newcastle. Other projects in course of construction at the end of the year included area offices and a call stand in Hull (Victoria Dock) and call stands and offices at Greenock and Fleetwood, while planning work has continued for other buildings scheduled for construction during the coming year.

Welfare

Ten years ago Port Medical Services were set up by the Ministry of War Transport in Liverpool and Glasgow, the primary purpose of which was to provide an accident service for minor injuries. The Board has continued to develop these services and by the end of the year there were 42 Medical Centres and seven First Aid Rooms in 23 ports, staffed by 64 nurses and supervised by four Regional Medical Officers. The Medical Service is available to all workers on the docks, and the employers of workers other than dock workers are invited to make a token contribution based on the treatments given to their employees.

The Board notes the increasing development, particularly in London, of welfare activities organised, administered and, in part, financed by the men. During 1953 through regular deductions from wages some 29,000 men contributed nearly £21,600 in membership fees to their clubs, sports and social organisations; 36,000 men contributed £77,000 to benevolent funds; £192,812 was deducted for National Savings from 6,887 men—an average of £28 per man.

Port Workers' Education Classes for the study of port working were held in 22 ports during the winter session 1952-53. Of the 703 enrolled members who completed the course, 221 were registered dock workers; 33 classes have been organised for the 1953-54 session, attended by 116 dock workers. Some of those who successfully completed the earlier courses are now proceeding to the graduateship of the Institute of Transport.

Dock Workers Clubs have been opened during the year in London (London and St. Katharine Docks), Dundee, Yarmouth and Plymouth, premises have been purchased at Ardrossan and Tilbury and adaptations are proceeding. There are now 23 clubs, owned by dock workers, with a membership of 23,200 and a subscription income of some £18,000.

Improved Financial Reserves.

In regard to finance, by the end of 1952, the steps taken to regulate the labour force and the raising of the rates of percentage payments had begun to restore the Board's depleted finances. The cumulative effect of these measures was assisted by the gradual improvement in the volume of employment, so that, after building up its reserves to a satisfactory level, the Board was able to announce, in June, its intention of reducing its levy on employers:—

- from 22½ per cent. to 16½ per cent. on the wages of daily workers employed on work other than coastal traffic;
- from 15 per cent. to 11½ per cent. on the wages of daily workers employed on coastal traffic; and
- from 7 per cent. to 5 per cent. on the wages of all weekly workers.

The new rates became effective on 1st August and were fixed at a level which the Board hoped to be able to maintain for a reasonable initial period as a move towards the greater stability in the rates which it seeks to achieve.

Owing to the improvement in the level of employment and to the higher rates of wages for the last 12 weeks of the year, the Board's total revenue was substantially greater than had been expected, while lower labour surpluses than in 1952 resulted in corresponding decreases in expenditure on attendance money and guarantee make-up. In addition, capital expenditure fell short of estimates, and an improvement in the value of investments released more than half the reserves against potential losses (£125,000) set aside in previous years. As a result, the net surplus on management fund for the year (after transferring to General Welfare Fund income equivalent to ¼ per cent. on the wages of all registered workers) was £1,556,828.

Palletisation and Shipping — 1954

(1) Current Developments

By E. S. TOOTH

In December, 1952, a technical committee of the International Organisation for Standardisation held its first meeting to consider standards for "Pallets for the Unit Load Method of Materials Handling." The conference lasted three days and representatives of nine nations and four international organisations attended. The agenda was a long one and considerable progress was made; the meeting considered that the important factors controlling pallet standards are (1) the need for the pallet to be suitable in size and construction to carry an economic load (from the shipper's point of view) to foreign destination, and (2) the necessity for its dimensions to be such that it can be stowed economically in road or rail transport vehicles. With these two points in mind, it recommended that the following two sizes be standardised: 40-in. x 48-in. and 32-in. x 48-in.

Other resolutions concerned (a) additional sizes to be considered at the next meeting, (b) the need to establish an international standard for a pallet especially for sea transport, and (c) details of the construction of standard pallets, particularly as they concern the entry of the forks of a lifting truck.

The I.S.O. technical committee will continue its work at a second three-day meeting in June of this year, and a working party drawn from the delegations from Australia, Belgium, France, Germany, the Netherlands, Norway, Sweden, Switzerland and the United Kingdom has been doing preparatory work in the meantime. Thus there will be reports before the meeting upon such matters as the size and position of openings in the bottom deck of standard pallets, the width of the wing of a wing-pallet, nominal rating of pallets, materials for construction of pallets, and terminology and definitions. Besides these matters, the June meeting will probably consider additional sizes proposed for adoption as standards by Australia, France and the United Kingdom, means of securing loads to standard pallets, the limitation of the dimensions of the load on the pallet and the need to formulate a standard for the "sea-transport" pallet.

This would seem an appropriate time, therefore, to review the position of palletisation in the shipping industry and, from existing trends (of which standardisation is one), to try to form some idea of what the future holds, particularly with regard to the carrying of palletised cargo in deep sea vessels.

Recipients of the Benefits of Palletisation.

In the sphere of palletisation, there is a considerable difference between developments in the short-sea and coastal trades and those in trans-ocean trading. One of the main reasons for this difference is that, in the former, there is greater incentive and better opportunity to exploit the use of pallets.

Among the benefits accruing from palletisation are "cleaner" and less arduous handling, reduced breakage and pilfering losses, a considerable increase in transit shed capacity (resulting from high piling by fork-lift truck) and the speedier turn-round often given to road and rail vehicles. As will be appreciated, these mainly concern the manufacturer, the shipper, the wharfinger, the stevedore, the dock authority, the cartage and railway contractor, the customs authority, the receiver and, of course, the port worker; they cannot be considered as strong incentives to the shipping company to take active steps to encourage palletisation. (Neither, for that matter, can the shipping company be expected to be directly interested in the difficulties encountered by road haulage contractors and railway organisations when confronted with consignments of unit loads of unsuitable dimensions for their vehicles.)

It is obvious that palletisation can only be successful in sea transport if it is attractive to the shipping company and the two main aspects with which this interest will be concerned are (1) savings in loading and discharging times (a benefit) and (2) the occupation of freight space by pallets, whether loaded or "returned empty" (a problem).

When the sea journey is measured in terms of hours, the saving of a tide at each loading and discharging is an appreciable economy, which may more than compensate for (a) the loss of freight space due to the use of pallets and (b) the cost of the special mechanical equipment needed to handle palletised consignments. In trans-ocean traffic, however, the sea journey is measured in terms of days—seven to fourteen, say—and the saving in loading and discharging time represents a much smaller proportion of the total time of a return journey.

There are other factors which touch upon this matter. Whatever the type of cargo, but particularly with palletised goods, the short-sea vessel is usually easier to load and discharge than the conventional ocean-going general cargo ship with 'tween decks, alleyways, propellor-shaft tunnels, deep tanks, etc. Quite often, too, the small vessel runs regularly between the same few ports and the dock operating staff become familiar with its requirements. A final point is that more than occasionally, the short-sea and coastal vessel is not filled to capacity and thus the occupation of freight space by pallets may not present a problem.

The benefits which palletisation can bring to the shipping industry, therefore, will, for the time being at least, be of much greater interest to those companies concerned with short-sea trading than to those engaged in trans-ocean traffic.

Palletisation in Short Sea Traffic.

The position at the present time confirms this contention. There are developments in palletised traffic in many parts of the world, but mainly in coastal, lake and short-sea traffic. Some of these have been evolving for a number of years, some are recent.

Between Algiers and Rouen, for example, agricultural produce and vegetables are carried on metal alloy or wooden pallets measuring about 39-in. x 52-in., each having four sling attachments and also chains and butterfly fastenings. The complement of each pallet is a cover of the same dimensions and material. The method of use is to pile the goods on the pallet to the appropriate height, place the cover on top of them and then make the whole into a secure load by using the chains and fastenings.

It is claimed that the cost of loading is not increased, because the building up of "container" loads is not more expensive and arduous than placing unpalletised goods in a sling. Moreover, with unpalletised cargo, particularly of this nature, there is much broken stowage and consequent loss of freight space. Most important of all, however, is that at unloading, outputs are doubled.

In the North American continent there has been a different reason for the main developments in palletised shipping traffic. Here, large quantities of goods in homogeneous packages lend themselves to palletisation, especially where, as is frequently the case, the traffic is a regular one. Between certain Great Lakes and Canadian ports there is a volume of traffic of this kind and so satisfactory has the system proved that in some cases it has been worth while to construct vessels especially designed with side "hatchways" for loading and discharging palletised cargo.

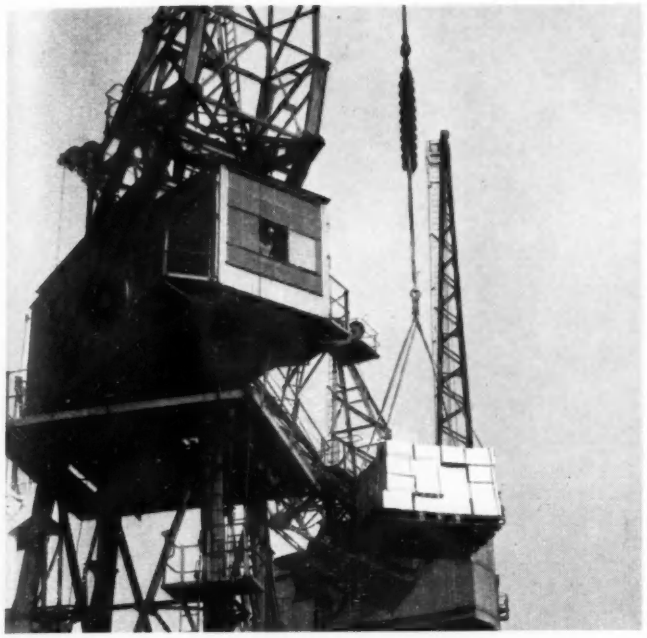
In some ports in the U.S.A., the making of goods into unit loads (with or without pallets) is performed at distributors' premises near the export berth. After transfer to the dockside transit shed, in which they are piled four or five loads high, the unit loads are taken to the ship's side by fork truck, lifted aboard and stowed in space especially reserved for this type of cargo. The consignment for one ship may be as much as 500 tons. Empty pallets are ultimately returned by the receiver to the port of loading and, it is believed, often create a minor freight-space problem. This also, of course, is a regular traffic.

An example of a completely different kind is the coastal service run from Copenhagen. This caters for heterogeneous goods—the kind of mixed consignments known to Britishers as "Carter Paterson" traffic.

Palletisation is done at the dock and, because the cargo is so miscellaneous, several kinds of pallets—flat, box, nesting, sided—are used. Fork-lift trucks and pallet trucks are employed on the quay and, to facilitate loading and discharging, some of the ships are fitted with special cranes, while others have hatch lifts. Some ships, too, have folding hatch covers.

An example of a dramatic increase in handling speeds resulting from making goods into unit loads comes from Leith and Grangemouth on the east coast of Scotland. At these ports, fire bricks have been regularly loaded by manual gangs from railway wagon to coastal vessel at an average speed of some 17 tons per gang per hour. Since the bricks have been made into unit loads, each

Palletisation and Shipping—1954—continued



[Photo courtesy of P.L.A.
Lifting cases of canned goods ashore.

approximately 3 cu. ft., the speed of handling has risen to 55 tons per gang per hour.

The bulk of the unit load cargo in Europe is carried between the ports of Norway, Sweden, Denmark, Holland, Belgium, France and Great Britain. In many cases the traffic is small and intermittent; here and there it is regular—and instances of this occur between Esbjerg (Denmark) and Harwich, Oslo and Antwerp, and Bergen and Newcastle. Each has its particular features, but that chosen for description is the last-named, since in this case many of the pallets (which all belong to the shipping company) travel outside the dock area at each of the terminal ports.

Certain goods (chemicals in bags, for example) are made into unit loads at shippers' premises in Norway, are brought across the North Sea to the Tyne and remain palletised until they reach the receivers' premises, where they are unloaded from vehicle by fork-lift truck. Cases of fish are palletised and brought down the Norwegian coast by small coastal craft to Bergen, where they are transhipped, still as palletised unit loads, into the Tyne-bound ship.

The pallets used in this trade are of two kinds—wooden and metal—and are of Norwegian manufacture. The wooden pallets are used for bag, bale and case cargo, the metal ones, which are of the nesting type, for the cases of fish, the liquid from which does not affect metal as it does wood. Fork-lift trucks of 4,000 lbs., 5,000 lbs. and 6,000 lbs. capacity respectively are used in the transit sheds; one pedestrian pallet truck is allocated to each hold in the ship. It is claimed that this mechanised system, employing shipping-company owned pallets, has increased speeds of loading and discharging by 40/60 per cent.

"Throughout Movement" in Trans-Ocean Traffic.

As will be seen, there is sufficient evidence of palletisation in short-sea traffic to warrant the conclusion that its development in this sphere is appreciable. The same cannot yet be said of palletisation in trans-ocean trade. The development which has often been predicted here (now, however, with decreasing certainty) is also, of course, the transporting of goods in palletised unit loads from manufacturers' or shippers' premises to receivers' premises abroad—the "throughout movement" method, as it is called.

The several interests affected by the introduction of this method of goods handling have already been mentioned; and if indeed some of them are to reap substantial benefits from the change from package-handling to load-handling, then those particular ones must already have a strong incentive to try to get it inaugurated. Since, however, there have been no appreciable developments of this kind in trans-ocean trade, the matter cannot be as straightforward as it is usually assumed to be.

During the last war, the United States Navy developed the use of a two-way pallet measuring 48-in. x 48-in., which proved a great saver of handling time. After the war, this pallet was dispensed with in favour of a 40-in. x 48-in. four-way pallet which was better suited to American road and rail vehicles and which, in many quarters, was expected to be generally adopted by American Industry. Developments is the throughout-movement method in both the United States and Canada, however, have disappointed many prophets and it is said that in Canada only one shipper is using palletisation extensively.

Some authorities have attributed this, at least partly, to the failure of American railway interests to adapt their tariff policy to the requirements of the new method of goods handling. Until quite recently, full freight rates have had to be paid for the weight of the pallet on which goods are loaded and no important concessions have been granted in respect of pallets returned empty. This position is compared with that in Europe where, for instance, the Swedish, Swiss and (more recently) British and Finnish railway authorities grant free conveyance of consignors' loaded and empty pallets (provided they are of specified size, design and weight), and the Swiss and German Railways have an arrangement for pallet exchange. In some countries, the Railway Authorities provide their goods sheds with pallets of their own. The Dutch Railways provide pallets for merchants' use.

Much of this international traffic is, of course, across land boundaries. Because of its geographical situation, however, it is not surprising that some of the first pilot experiments in sending commercial goods across the ocean originated in Great Britain. Cases of whisky, for example, were palletised in London (on American pallets) and shipped to destination in U.S.A. in unit load form.

The Rôle of the Fork Lift Truck.

Such traffic did not persist and the next development occurred because port authorities, shipping companies, and other labour contractors in many countries began to use fork-lift trucks, firstly to improve their goods-handling methods and to save shed space, and secondly to speed the turn-round of ships. At first this machine was regarded as the panacea for all industrial ills and although that opinion was quickly proved to be false, there is no doubt that the fork-lift truck is becoming invaluable to the port industry.

At the present time it is, in fact, the most universal handling device. It is used to lift, convey, turn, invert and rotate loads and even to pour from containers; and although gripping and other

[Photo courtesy of P.L.A.
Exports piled on pallets in a transit shed.

Palletisation and Shipping—1954—*continued*

devices have reduced the need for pallets, it is true to say that the introduction of the machine into port-operating work has done much to make port authorities, shipping companies, stevedores and others pallet-minded.

The Stevedores' Pallet.

Hence, at an increasing number of deep water berths in many British and foreign ports, we now find in use a special kind of pallet which has been introduced by one or other of these organisations, either solely as a dock tool or to carry loads between port and port. This "stevedores' pallet," as it has become known, is an article around which certain controversy ranges and it will be of interest here to examine its present position in the industry.

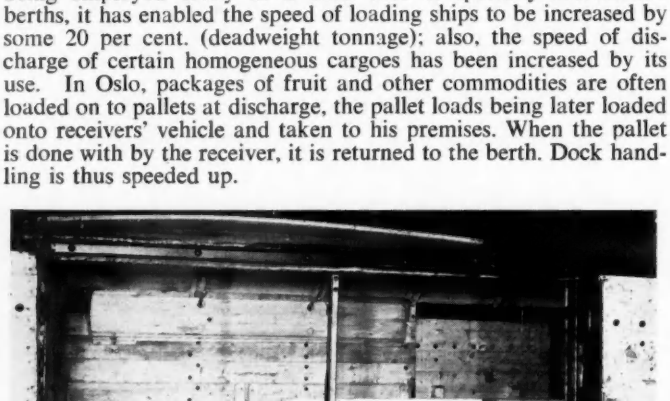
It has two important aspects—size and design. It is long and wide, so that it can carry an economic load for quay crane or ship's purchase; it is constructed so that it can be conveyed by fork-lift truck and also handled by crane—that is, besides having two decks, it usually has either lifting eyes or strong wings.

A British version of this pallet measures 54-in. x 72-in. and has a metal lifting eye welded at each corner. The Netherlands' counterpart is a wing-pallet, measuring 48-in. x 72-in. and is often used for carrying two 40-in. x 48-in. "normal" pallets. (It could, of course, also carry two pallets of the other recommended standard size, viz. 32-in. x 48-in.).

The stevedores' pallet in use in Scandinavia and Denmark is also wing-typed but measures 48-in. x 64-in. In Norway particularly, this pallet is used for both coastal and overseas traffic and its adoption as a standard size would, in 1952, have satisfied the delegations from Norway, Sweden and Denmark. At that time, however, the French delegation favoured the Netherlands' size of pallet—48-in. x 72-in.

In some countries, the opinion is strongly held that, in the future, the bulk of palletised cargo in sea transport will be handled on the stevedores' pallet and will not be palletised at production or shippers' premises. Hence the desire to standardise the stevedores' pallet.

This matter is of great importance to shipping interests all over the world and it is pertinent to note that in the North American continent and in the north-western countries of Europe particularly, the stevedores' pallet is already in general use. In London, being employed solely as a dock tool at specially mechanised berths, it has enabled the speed of loading ships to be increased by some 20 per cent. (deadweight tonnage); also, the speed of discharge of certain homogeneous cargoes has been increased by its use. In Oslo, packages of fruit and other commodities are often loaded on to pallets at discharge, the pallet loads being later loaded onto receivers' vehicle and taken to his premises. When the pallet is done with by the receiver, it is returned to the berth. Dock handling is thus speeded up.



[Photo courtesy of British Railways

New pallet railway wagon being loaded with pallets of sizes already recommended for standardisation.

[Photo courtesy British Road Services, B.T.C.

Lorry with 1½-in. raves loaded with pallets which have their 48-in. sides across the vehicle and their 40-in. sides resting on the raves.

Another example of the extensive use of the stevedores' pallet solely as a dock tool for handling homogeneous goods comes from Long Beach, California. Bales of cotton are palletised before being stowed in transit sheds to await shipment to nations all over the world. When the loaded pallets are ultimately tendered at the ship's side, the bales are unloaded from them into the stevedores' slings. Hundreds of thousands of these bales are handled annually in this manner and the saving in shed space is very large. In the U.S.A., one kind of dock pallet is the roller-pallet, which can be pushed into a vehicle, loaded, rolled and carried to stowage by fork-lift truck.

In French ports it is estimated that there are 80/90,000 stevedores' pallets, of which perhaps 80 per cent. are used in Marseilles. Most of these are employed solely as dock tools, for storing goods in sheds or in the open, for handling operations on quay and for loading and unloading ships. They never leave the port areas and they do not form a means of transport. The majority of them measure 48-in. x 72-in.

There are, however, instances where this French pallet is used between port and port. For some time, cases of liquid goods have been palletised at Le Havre and Bordeaux and shipped to New York. The shipping company concerned owns several hundreds of these pallets, which are strong enough to carry a load of one ton and to last for several years. This is valuable merchandise and one of the important benefits of palletising it has been the total elimination of losses and breakages.

A second instance, from Marseilles, is the palletisation of bags of refined sugar, which has recently been undertaken by a large refinery in the south of France. The bags are piled on pallets (again approximately 48-in. x 72-in.) in the factory, brought to the port on lorries and loaded, still palletised, onto overseas vessel.

The foregoing examples are sufficient to show that the stevedores' pallet is being employed in different ways by different interests. It would obviously clarify the situation if a distinction were always made between the pallet used only as a dock tool and that which is sea-borne. In certain European countries there is a tendency to refer to the latter as a "maritime" pallet (although the term is still used in a very general sense) and this appears to be a useful trend to follow. However, it is now clear that the pallets which have been generally called "stevedores' pallets" are being employed in at least three different ways: (1) simply and solely as dock tools for handling goods through transit shed on to ship, and vice versa; (2) as shipping company's tools for quick loading, stowing and discharge, in which case they travel between port and port but never out of the dock area; and (3) as "through-transit" pallets (still shipping-company owned) carrying goods either the complete journey from manufacturer's premises to receiver's depot abroad, or for some part of that journey, involving, of course, more than just sea transport.

Palletisation and Shipping—1954—continued

The Problem of Standardising the "Stevedores' Pallet."

The standardising of this special pallet presents an unusual problem—and immediately it arises, the advantage of distinguishing between a "dock-tool" pallet and a "maritime" pallet is emphasised. There seems little benefit to be derived from standardising a dock tool, since the "geography," the working conditions, and thus the equipment of the ports of the world vary over such an immensely wide range.

Those pressing for a standard to be formulated for a "maritime" pallet, however, have a much better case—but here again there is more than one conception of how this pallet would be used. Some assert that when such pallets are standardised, they will be able to do a round trip—from, say, Britain to the U.S.A., from the U.S.A. to Africa, from Africa to Belgium and from Belgium to Britain, being unloaded and reloaded with different goods at the various ports concerned. These pallets are expensive, however, and it would seem that the question of ownership alone would loom so large as to make such an arrangement impracticable. Pallets at present used between port and port are shipping-company owned and do not do a round trip.

The main case in favour of standardising the maritime pallet is based on the argument that, whatever the future holds, more and more shipping companies will use it for regular cargo services, keeping it always within their own control. Port authorities, stevedores and other labour contractors will therefore have to deal with increasing quantities of these pallets and considerable difficulties and delays will result if they are of miscellaneous sizes and designs.

This argument is undoubtedly valid, but there is yet another aspect of this complex matter to be considered. The smaller pallet sizes (40-in. x 48-in. and 32-in. x 48-in.) have been recommended as standards because they are suitable for the road and rail transport vehicles of the various nations. In certain countries, a pallet 48-in. x 72-in. would not always be a practical proposition for such transport. It would certainly present major difficulties to British railway and road transport.

A final but extremely important question is, therefore: What will be the effect on the throughout movement method if (assisted by standardisation) the use of the maritime pallet continues to be developed? International standardisation of "normal" pallet sizes is undertaken to foster the transport of goods in unit loads from factory to foreign destination. This being so, does not the increasing use of the maritime pallet tend to postpone this development?

This question is answered in some quarters by the assertion that, when palletised goods are tendered to ports, they will be placed on maritime pallets, the size of which will be suitable to carry two "normal" pallets. The whole will then be shipped and will remain in ship until discharged at foreign port, when the unit loads will continue their journey and the maritime pallets will remain at the port to be reloaded. This arrangement would involve such a big loss of freight space (there being two "thicknesses" of pallets—say 12-in.—for each unit load) that it is believed it would be unacceptable at least to British shipping interests.

Summarising, therefore, the view is held (1) that there is no need to standardise the pallet as a dock-tool; (2) that maritime pallets are too big for road and rail transport; and (3) that it might prejudice the development of the throughout movement method if a standard were formulated for a pallet to carry goods on only part of their journey.

As far as (3) is concerned, however, there is no doubt that at the present time there is little or no tendency towards the development of the throughout movement method in trans-ocean trading. Consequently, it is true to say that the increasing use of the maritime pallet has benefited the industry without delaying other desired developments. If, however, the standardising of such pallet sizes as 40-in. x 48-in. and 32-in. x 48-in. is to have any purpose at all, it is to ease the many difficulties which have been encountered by those interests who wish to ship their goods in unit load form. Will it ultimately do this? Is the employment of the maritime pallet a short- or long-term expedient? Will its increasing use tend to delay the development of the throughout movement method?

The recommendations of the second meeting of the I.S.O. technical committee will bear on the matters raised in these questions. They will therefore be discussed briefly in a further article in the July issue of this Journal.

Correspondence

To the Editor of *The Dock and Harbour Authority.*

Dear Sir,

Land Reclamation.

In your Editorial Comments (May, 1954) upon the possibility of reclaiming more land from the Wash, you suggest that the Wash should be treated as a whole and that by extending existing training works according to an overall plan, accretion can be speeded up and drainage improved at the same time.

In addition, of course, we must not forget that it is also necessary to maintain the navigation facilities into and out of the Wash ports and possibly to improve them.

The idea of treating the Wash as a whole is not a new one. During the first half of the 19th century Sir John Rennie proposed by means of training walls to conduct the outfalls of the Rivers Ouse, Welland, Witham and Nene to a common outfall in the Wash and to reclaim the land between. He estimated that some 150,000 acres could be reclaimed and named them in anticipation, "Victoria County."

Although this ambitious scheme was never carried out, the Norfolk Estuary Company did subsequently obtain statutory powers for lesser works and the present training works at the mouth of the River Great Ouse at King's Lynn are based on the Rennie Scheme.

Also the desirability of collecting and collating survey information and data for the whole of the Wash as a necessary preliminary to any works there, was recognised and discussed at a conference of local authorities at King's Lynn as recently as February, 1948. At that Conference a Technical Sub-Committee was set up to prepare a scheme, but after a few months the proposals had to be abandoned for various reasons, and have never been revived.

Harbour Office,
King's Lynn.
25th May, 1954.

Yours faithfully,
TOM VALENTINE.

Obituary

Mr. F. M. G. Du-Plat-Taylor

We regret to announce the death of Mr. F. M. G. Du-Plat-Taylor, which occurred on May 22nd at the age of 75.

Mr. Du-Plat-Taylor was educated at Farnborough School and Winchester College, and received his technical education and training at London University, where he graduated in 1896. After serving with Mr. A. G. Lyster, a past President of the Institute of Civil Engineers, he was employed on the engineering staff of the Mersey Docks and Harbour Board, and in 1904 he joined the staff of the London and India Docks Company, becoming resident engineer on the East and West India Docks. He continued to work in this capacity when the Port of London Authority was formed, and obtained further experience as resident engineer at Tilbury, where his duties included supervision of the construction of the Tilbury main dock extension and a deep water jetty.

After service with the Royal Artillery in the 1914-1918 war, Mr. Du-Plat-Taylor was elected in 1919 to membership of the Institute of Civil Engineers, and continued with the Port of London Authority until 1924, when he started as a consulting engineer, in partnership with Dr. Cunningham, the late Editor of this Journal. Upon the dissolution of the partnership, Mr. Du-Plat-Taylor continued as a consultant, his practice being chiefly connected with harbour and maritime works, including sea defence schemes, and involving maintenance as well as new construction. He contributed a number of papers to various technical institutions, and also was the author of several works on maritime engineering. His books "Docks, Wharves and Piers" and "The Reclamation of Land from the Sea" are well known as standard works of reference on these subjects.

Mr. F. M. G. Du-Plat-Taylor had many connections with civil engineers in France, and was an Officier d'Academie, and a past-president of the British section of the French Society of Civil Engineers. He was also a member of the Institution of Mechanical Engineers, and of the Association of Consulting Engineers.

Mechanical Handling Exhibition and Convention

The fourth Mechanical Handling Exhibition and Convention held at Olympia, London, was opened on the 9th of June by Mr. A. R. W. Low, C.B.E., D.S.O., M.P., Parliamentary Secretary to the Ministry of Supply. The organisers claim that a larger display of mechanical handling equipment was on view than anywhere previously located in one spot at one time in the world. The increase in the use of mechanical handling equipment may be judged to a certain extent by the number of industrial fork-lift and run-about trucks manufactured in the United Kingdom. In 1937 the output was 167 trucks, and in 1953 the number manufactured was no less than 6,000. Interest in mechanical handling is growing rapidly which is understandable when one remembers that in producing an article nearly 80 per cent. of its price is represented by handling costs, and that movement adds to the cost but not to the value of the goods.

Some 70 professional institutions and trade associations accepted invitations to pay official visits to the exhibition and included among them was the Dock and Harbour Authorities' Association. Apart from the exhibition no less than eleven papers were presented at the convention dealing fully with specific types of equipment and handling problems, and included one on the "Philosophy of Cargo Handling" which was sponsored by the International Cargo Handling Co-ordination Association. Films shown in the exhibition cinema included " John Anderson " showing the operating of floating pneumatic grain handling plant in the Port of London and another, the " Port of Bristol " dealing with bulk handling equipment and cranes, trucks etc. in that port.

Touring the exhibition one was impressed by the developments which have taken place in recent years: the improvements on the original design, and the manner in which special equipment has been devised to deal with particular but repeated operations.

Extensive Range of Mobile Cranes.

Dominating over smaller exhibits was the largest mobile crane ever built; this is capable of lifting 41 tons at 12-ft. radius. A lesser-known type of mobile crane was one which is operated pneumatically and which the makers claim can lower a load onto a pencil point without breaking it. It has a capacity of 1 ton or 2 tons and is suitable for use in the restricted space of a warehouse. A newcomer to the range of mobile cranes is an exceptionally versatile machine for work on constructional sites. With a maximum load rating of 7½ tons, it has both the stability, height of lift, and outreach needed for erection work, and with complete mobility over rough or soft ground, is able to undertake heavier general lifting work anywhere on the site. The standard jib is of lattice construction and consists of four sections which can be assembled to provide working heights of 25, 45 and 65 feet. This will normally be fitted with a 9-ft. 6-in. jury mast jib extension, designed to give the advantages of a swan-neck jib without sacrificing the crane's capacity for straight jib working.

Another distinct type of crane exhibited was the "Jumbo" mobile with capacities ranging from 2 to 6 tons. These cranes are hydraulically operated and are designed to operate hydraulic grabs and other attachments.

Fork-Lift Truck Development.

Fork-lift trucks of varying capacity and in great variety, petrol, diesel, and electric powered, were exhibited by a score of manufacturers as were also pallets, containers, and stillages. For the first time in this country industrial television equipment was used for display purposes, a Pye closed circuit television being employed to enable the largest possible number of people to view demonstrations of exhibits from different angles at one time. The construction of the stand itself was unique in that the raised office was supported by five Stacatruc fork-lift trucks. Each side was constructed so that it represented the end view of a pallet load of cartoned goods, and in each of these sides were incorporated two television receiving sets which provided pictures of the demonstration at angles covering all viewpoints around the stand.

A newly modified Stacatruc battery electric fork-lift truck specially constructed for work of a tough nature in heavy industries, docks and harbours, etc., has a maximum lift of 12-ft. and a maximum load capacity of 4,430 lbs.

Another development in fork-lift trucks was one with a long wheelbase designed for use in overseas areas where ground conditions are difficult and the top surface may be snow, ice, mud, or ashes.

Claimed to the first full-clamp to be perfected in this country is a rotating reel clamp attachment which can be fitted to any of the " Conveyancer " range of trucks. It is particularly suitable for picking up reels of paper in the horizontal or vertical position and rotating through 90° for stacking three high, re-stacking, or transport.

A 1,000 lb. capacity fork-lift auto-truck exhibited for the first time lifts from a minimum height of 2¼-in. to 9-ft. in approximately 20 seconds.

A new heavy duty fork-lift truck with a maximum capacity of 7,000 lbs. has lift heights available of 6, 9, 12 and 14 feet. The addition of two 3-ton trailers which can also be handled provides a total load-carrying capacity of more than 9 tons.

The latest models of straddle carriers are capable of picking up, transporting and setting down loads of up to 10 tons in weight and 40-ft. in length at a rate of over 300 tons an hour. Power is supplied by a diesel engine developing 65 h.p. and capable of speeds of 25 m.p.h. forwards or in reverse. Suitable ancillary equipment has been designed to enable the units to handle, in addition to timber, steel sections, tubes, etc., and such items as cable drums, loads of bricks, oil drums, or reels of paper.

Grain handling plant included a pneumatic " Grain Vayor " Mark 10D, driven by a Lister diesel engine. A replica of this machine has been tested under working conditions at Gloucester Docks unloading cargoes and delivering on the suction side to the top of a mill. The overall distance was 80-ft. and the machine handled 20/30 tons per hour. At another stand was exhibited a scale model (⅜-in.=1-ft.) of a floating pneumatic grain elevator capable of discharging at the rate of 300 tons per hour. The model is of the type of the two most modern elevators used by the Port of London Authority.

Pallets and Stillages.

Nearly forty manufacturers exhibited different types of pallets and stillages. The materials used in construction were fresh-sawn hardwood, seasoned hardwood, softwood, plywood, steel, alloy, and timber and steel combination. Other pallets were constructed from rolled or pressed sections, round or square tubes. There was a collapsible lightweight pallet for cargo handling, eleven empty ones occupying the space of one full one. Collapsible stacking stillages were exhibited which tiered on one another when open or closed, and, when collapsed saved at least two-thirds of the space. Other stillages had hinged doors or removable sides for loading and unloading, some sides being of mild steel panelling and others of mesh.

Re-usable transit cases of one-piece rivetted plywood and steel construction with the steel reinforcement of special temper to permit of repeated folding, were claimed to be a new approach to the provision of low-cost collapsible packaging material and were stated to last a minimum of 20 journeys with a usual expectation of more than 40 journeys under normal handling conditions.

Many types of conveyors were on view including overhead, belt, chain, roller, vibrating, and tubular. Other exhibits included conveyor driving heads, and conveyor buckets. The conveyors ranged from small roller sections to aerial ropeways and specialised conveyors to deal with a wide range of commodities from bottles to bulk ore.

Lorry-loading equipment included fork-lift trucks specially designed for this purpose, and a power-operated machine for loading and off-loading drums and barrels and the like, which can be fitted to most types of lorries and automatically stow away underneath the lorry. Another model is designed to load from the ground to lorry floor level open-topped containers and easily spillable goods of up to 3 cwt. in weight. Another, an hydraulic loader fitted to a lorry, lifts up to 1½ tons at the touch of a lever.

Other exhibits of interest to port operators ranged from a working Rotaside wagon tippler, handling a 24½-tons' capacity mineral wagon to cargo handling nets, lifting tackle of all types, grabs, chains, wheels for trucks, jacks, hoists, and skips.

Manufacturers' Announcements

British-built Straddle Carriers

Thos. W. Ward, Ltd., Albion Works, Shemeld, have recently been appointed sole Northern Distributors of the "Timber Wolf" and "Steelmaster" range of straddle carriers, which are designed and built by the British Straddle Carrier Company, Ltd., and are the only carriers produced in the Sterling Area.

These carriers replace existing methods of handling, loading, transporting and unloading lengthy, bulky loads up to 40-ft. in length and 22,000 lbs. in weight. Easily operated by one man, they pick up and set down their load in under 5 seconds, and can travel up to 25 m.p.h. in forward or reverse. They are diesel powered for economy and operate anywhere over rough tracks or thick mud. The driver has complete visibility fore and aft.

New 7½-ton Capacity Mobile Crane

The KL 75 Constructional Crane, designed by K and L Steelfounders and Engineers, Ltd., Associates of the "600" Group, is an exceptionally versatile machine for work on constructional sites. With a maximum load rating of 7½ tons, it has both the stability, height of lift and outreach needed for erection work and, also, has complete mobility over rough or soft ground.

In general, the new crane follows the proved pattern of the other models in the range, a Perkins diesel engine providing power for hoisting, slewing, derricking and travelling. The chassis is mounted on pneumatic-tyred wheels fitted with restrictor rings: 4-wheel differential drive is provided and steering is both automatically correcting and power-assisted. Outrigger jacks, give complete stability when handling maximum loads.

The standard jib is of lattice construction and consists of four sections which can be assembled to provide working lengths of 25, 45 and 65-ft. This will normally be fitted with a 9-ft. 6-in. Jury Mast jib extension, designed to give the advantages of a swan-neck jib without sacrificing the crane's capacity for straight jib working (the hoist rope can be re-reeved through the head of the straight jib in a matter of minutes.)

Alternate jibs can be fitted for specific duties, one of these being a 40-ft. swan-neck type permitting a 2-ton lift at 32-ft. radius.

New Heavy-Duty Fork Lift Truck

The new Stacatruc Model 60 DH, which has a maximum capacity of 7,000 lbs., has been designed to meet the growing demand for a heavy-duty fork-lift truck. It incorporates certain unique features in design and construction. These include oversize tyres, smooth Lockheed hydraulics, massive mast assembly, and compensated rear steering axle. Perhaps the most important feature of all, however, is the "split-chassis" construction which ensures easy access to all transmission parts for servicing purposes and obviates the necessity to strip a single component.

The truck is powered by a 4-cylinder engine, and the lubricating pump ensures high-pressure forced lubrication, whilst the oil bath air cleaner, with a washable and replaceable element, cleans the intake air to the engine. The atomisers are located in a very accessible position on the top of the cylinder head. Starting is easy, and the exhaust silencer has been specially designed to reduce fire risks. The engine, clutch, gearbox and drive axle are assembled as a complete unit, the drive axle being bolted directly to the chassis and the engine end being suspended on two rubber mountings.

The 60 DH models are easily manoeuvrable in confined spaces and narrow gangways, and are available with lift heights of 6, 9, 12 and 14-ft. Thus, 7,000 lbs. of material can be handled in one load, thereby freeing for production purposes valuable floor space normally used for storing. In addition, up to two three-ton trailers can be handled so that, with the load on the forks, these trailers together provide a total load carrying capacity of more than nine tons.

The Stacatruc is manufactured by I.T.D. Ltd., of 95-99, Ladbroke Grove, London.

Bulk Loader with Front Wheel Drive

It is claimed that the increased power and simple operation of the Matbro Super Loadstar can considerably reduce handling costs in the moving of large quantities of loose materials. The loader is capable of handling all types of heavy and awkward loose bulk under adverse conditions, and the front wheel drive gives the power to bite deeply into the material(s) to be moved. The machine has 16-in. ground clearance and the giant tyres of the driving wheels enables it to negotiate the worst of ground. Increased traction and side stability are obtained through the load being over the driving wheels. Loose substances such as sand, earth, stones, coke and breeze, and semi-liquids such as concrete aggregate can be handled in the hydraulically controlled bucket.

The powerful "bite" of the machine enables it to be used for stripping, and its range and versatility are further increased by the use of interchangeable attachments in place of the bucket. These are forks, crane and dozer blade.

The driver's seat is in a completely enclosed cab, with front-hinged hood, from which the entire bucket is in full view at all angles of lift. The cab being well forward of the engine, the driver is away from fumes, heat and vibration.

Control of the bucket and arms is hydraulic in all positions and the bucket is fully compensated. The standard bucket fitted is of 1 cubic yard capacity, but alternative sizes are available. The load capacity is 2,500 lbs.

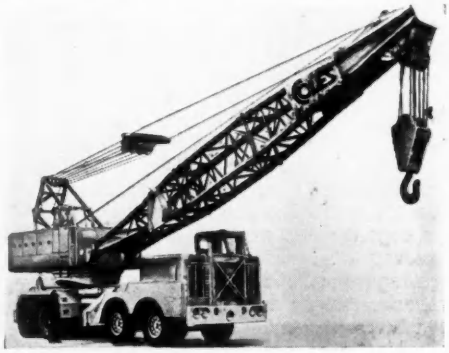
The Matbro Super Loadstar is designed and manufactured by Mathew Brothers, Sandy Lane North, Wallington, Surrey.

Manufacturers' Announcements—continued

The "Colossus" Mobile Crane

This largest mobile crane ever built, designed and manufactured by Steels Engineering Products, Ltd., of Sunderland, is fitted with a 30-ft. jib, and will lift 92,000 lbs. at 12-ft. radius.

A specially designed chassis has an 8-wheeled by 4 wheel drive, all wheels being fitted with compressed air brakes. The tyres



are 14-in. x 24-in. x 20 ply singles on four front wheels and twins on four rear wheels. A 250 h.p. diesel engine provides the travelling power, through a tandem drive with double reduction on each driven axle. Two 100 gallon fuel tanks are carried on the chassis, and telescopic girder stabilisers and screw jacks with large area floats are also provided.

The left-hand drive one-man chassis cab allows the jib to be stowed satisfactorily for travelling. Power-assisted steering is fitted to ensure finger tip control of the vehicle under all conditions. Twelve forward and three reverse speeds provide road speeds up to maximum legal limit.

The superstructure, which slews full circle, carries a 90-ft. strut jib of tubular lattice construction and an additional fly jib provides a maximum height of lift of over 100-ft. Power for crane motions is provided by an 80 h.p. engine mounted on the superstructure, driving a variable voltage generator. Hoist, Derrick and Slow motions are individually powered through separate electric motors supplied from the generator, and all motors are fitted with electro-mechanical brakes which are immediately applied should the supply of current be interrupted. The dimensions of the crane are: Clearance height, 16-ft.; tail radius, 12-ft.; wheelbase, 21-ft. The unladen weight is approximately 50 tons.

The Sherpa Hydraulic Truck

This new hand operated lifting truck is claimed to be the last link in modern mechanical handling — the link between levels that now require manual lifting and lowering operations.

The truck is of welded tubular construction, combining strength with lightness, and is designed for ease and manoeuvrability. The platform, mounted on four grooved rollers, runs freely on the front tubes and is supported by a roller chain passing over a cast iron pulley attached to the end of the ram. The high capacity specially designed hydraulic pump is mounted integral with the ram, and is fitted with a conveniently placed pump handle proportioned to ensure minimum effort. A safety valve is incorporated in the pump body which releases the pressure on excessive load. The pumps will lift a maximum load of 2½ cwt. to a height of 3-ft. in 30 seconds. A lever operated release valve arranged for finger-

tip control is provided enabling the platform to be lowered at suitable speed empty or loaded. The truck is 50-in. in height, and weighs 90 lbs. unladen.

The Sherpa is the latest product from Salisbury Precision Engineering, Ltd., Salisbury. Apart from the standard model, a convertible model is available designed for the easy adaptation of such special purpose attachments as Pallet Forks or a Barrel and Drum Lifting Device.

SITUATIONS VACANT

THE BOARD OF TRUSTEES OF THE PORT OF ADEN have a vacancy for a Surveyor and Mooring Master. The officer selected should be under 45 years of age, a trained hydrographic surveyor and, if possible, should have experience of work with heavy moorings and anchors. He will be required to establish a Hydrographic survey and Mooring Department for the Port of Aden, which includes the Oil Harbour at Little Aden. Salary scale £1,450 x 50 x £1,750, point of entry into the scale will be decided on engagement.

Free unfurnished quarters. Port Trust heavy furniture available at a nominal rental. Although described as unfurnished the quarters include refrigerator, electric stove and one air-conditioned room, if required, as standard fittings.

Free medical attention for self, but not hospital expenses. Medical attention for wife and family under contributory medical benefits scheme necessitating small monthly contribution, but not hospital expenses.

Participation in Aden Port Trust Contributory Pensions Fund (contribution 5% of salary) and Widows' & Orphans' Pensions Fund (5% of salary) compulsory.

Free first-class passages each way once during each tour for self, wife and children (not exceeding four). An equivalent allowance may be taken as an alternative to passages for those children between 8 and 18 years of age. Minimum tour 18 months, maximum usually not more than 30 months. Seven days' full pay leave for each completed month of service. Travelling time additional.

The successful candidate will be required to pass an examination in colloquial Arabic within 18 months from the date of arriving in Aden.

Form of application obtainable from Consulting Engineers and Agents, Aden Port Trust, 1, Lygon Place, Grosvenor Gardens, London, S.W.1.

THE BRITISH TRANSPORT COMMISSION DOCKS AND INLAND WATERWAYS, 22, Dorset Square, London, N.W.1, invite applications for the position of ENGINEERING ASSISTANT, Civil Engineer's Department, Humber Ports, Hull. Starting salary £820 per annum.

Applicants should have good practical experience of civil engineering work and be capable of preparing contract documents. It is desirable that candidates should be Corporate Members of the Institution of Civil Engineers or have passed Final Parts I and II of the Institution examination or hold a degree exempting therefrom, and intend to proceed to Associate Membership.

Applications should be sent to the Staff and Establishment Officer at the address shown above not later than 30th June, 1954.

WANTED

Back Numbers of "The Dock and Harbour Authority."

1949. March; April; June; July; November; December.
1950. January to December.
1951. February; March; July.
1952. February; March; May; June; October; December.
1953. January; March; April; September.

If you have copies available, please write Box 162, 19, Harcourt Street, London, W.1.

FOR HIRE OR SALE

CRANES AND LOCOMOTIVES FOR HIRE OR SALE.

10-ton Anderson Grice Steam Derrick Crane with 120-ft. Jib. 10-ton, 5-ton, 3-ton and 2-ton Steam Locomotive Cranes (standard gauge). Mobile Cranes up to 5-ton capacity. Standard gauge Steam Locomotives. 0-4-0 and 0-6-0. 10-in. and 14-in. bore x 18-in. stroke. 160-lbs. boiler. Abelson & Co. (Engineers), Ltd., Coventry Road, Sheldon, Birmingham, 26. 'Phone: Sheldon 2424.

FOR SALE

TWO UNUSED 355 b.h.p. 0-6-0 Diesel Electric Shunting Locomotives. 4′ 8½″ gauge, weight 55 tons, tractive effort 32,000 lbs. Price and details from: Box No. 161, "Dock & Harbour Authority," 19, Harcourt Street, London, W.1.

BUCKET DREDGER "ADUR"

SHOREHAM HARBOUR TRUSTEES will be inviting offers in August/September 1954 for the non self propelled bucket dredger "Adur". This dredger was built in Holland in 1901 and is of the following dimensions:

Length about 100-ft. x 20-ft. beam x 8-ft. depth moulded.
Draft about 4-ft.
Gross tonnage about 122.
Compound engines about 60 i.h.p.
1 S.E. boiler about 90 lbs. w.p.
Max. dredging depth about 22-ft.
Bucket capacity when filled level about 4.8 cu. ft.
(Particulars are furnished without prejudice or guarantee.)

If any intending purchaser wishes to inspect this dredger while working, this may be done during June by arrangement with the undersigned.

Harbour Office,
Southwick, Sussex.

A. G. STEPHENSON,
Clerk, Harbourmaster & Engineer.